DISCOVERY

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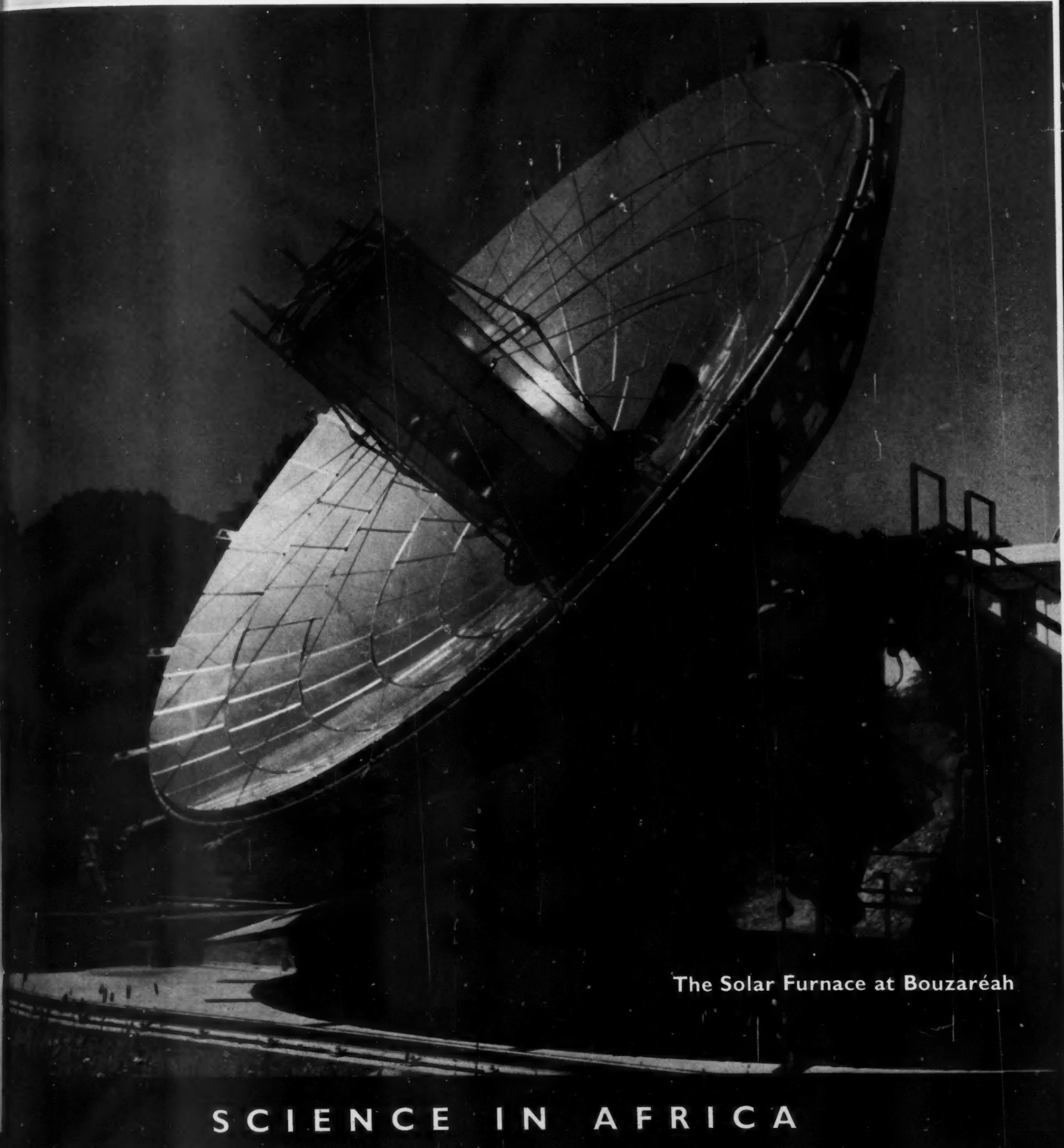
MARCH 1960 2/6



The Solar Furnace at Bouzaréah

SCIENCE IN AFRICA

DISCOVERY

VOLUME XXI MARCH 1960 NUMBER 3

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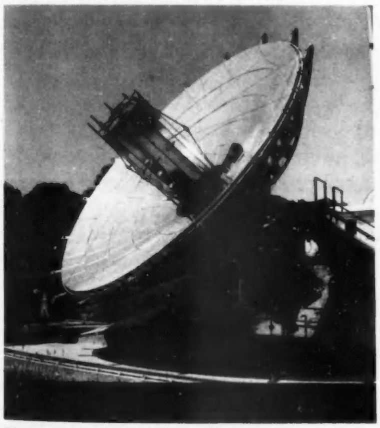

The Solar Furnace at Bouzaréah in the Sahara (See p. 103).

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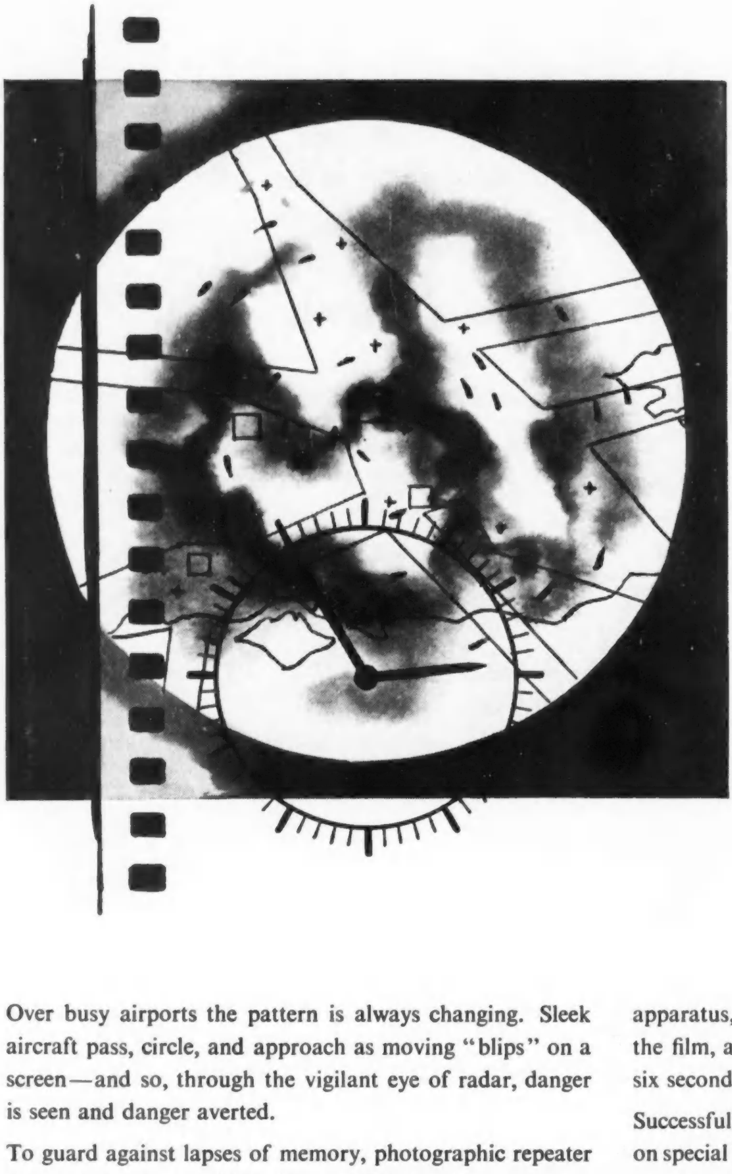
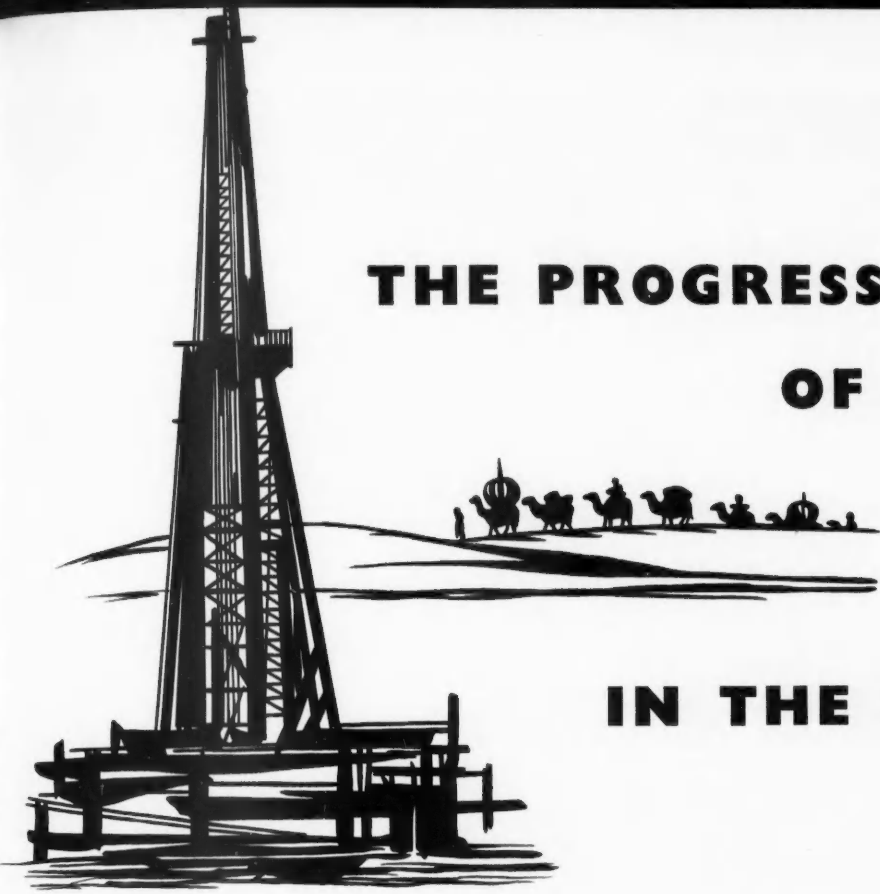




THE PROGRESS OF SCIENCE IN THE SAHARA

THE DILEMMA

"In many parts of the world advances in public health, improved sanitation, the avoidance of epidemics, the fighting of insect-borne diseases, the lowering of infantile death rates and a prolongation of the span of life have led to vast increases of population. Not only is the population increasing but in many places its rate of increase is still rising: and these processes will take so long to reverse that for many years to come the shortage of natural resources, particularly of food, is bound to provide increasing deprivation and disturbance. . . . If ethical principles deny our right to do evil in order that good may come, are we justified in doing good when the foreseeable consequence is evil?"

It was Prof. A. V. Hill who posed this ethical dilemma of science in his Presidential Address to the British Association in 1952, and he then quoted India as an example of such a vast increase of population. If, today, he wanted a better example, he might well cite Algeria. It is essential for an understanding of North Africa and of the role which science is playing there at present and in the future, that the population background and the economic planning consequent upon it are briefly outlined. As Algeria has perhaps felt the impact of European ideas for a longer stretch of time than most other parts of Africa—since the beginning of the French occupation in 1830—it might well be the true pilot plant for the whole of Africa, and thus indicate the trend of events elsewhere.

Since the beginning of this century, the African—and of course the European—populations in Algeria have had the ever-increasing benefit of medical scientific advance, and furthermore the French colonial administration succeeded in stopping tribal warfare. The results of "doing good" were not surprising. The birthrate in Algerian territories, including the Sahara, is now 4·5% with a death rate of 1·5% to 2%, thus giving an annual net increase in the population of 2·75%. This figure should be compared with the average increase of world population at a rate of 1·6% and with the highest rates of China and Brazil namely 2·4%.

The total population of Algeria was 10 million in 1958; assuming the same rate of increase, it will be 13·5 million in 1968, 17·7 in 1978 and by the year 2000 it will have reached 32·2 million. Equally revealing is the age structure of the African population in Algeria: 52·5% under the age of 20, 42% of adults, and only 5·5% above the age of 60. One of the main contributing factors to the Algerian situation is the early age of marriage of African girls, namely from 14 years upwards; in fact, economists allow five African generations per century, as compared to three to four European during the same time. These figures are indeed frightening, particularly when it is borne in mind that one of the possible remedies, namely family planning and birth control, now beginning to be accepted in India and Japan, is of course quite unacceptable to the French administration or to the African Moslems. Prof. Hill has indeed well posed the dilemma which faces the French administrators of Algeria. Their solution is in the Plan Constantine.

THE PLAN CONSTANTINE

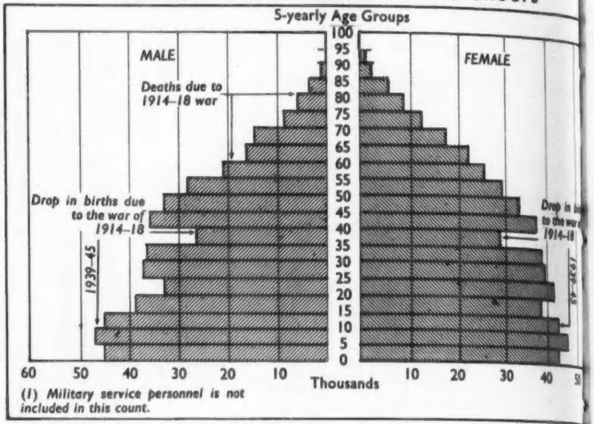
The foreseeable consequences of this quite unprecedented increase in population led a group of young Algerian civil servants to formulate a number of economic remedies; these were officially adopted by General de Gaulle in his speech at Constantine in 1958. Essentially they form a five-year plan, 1958–1963, and the economic planners realise that this is merely a beginning. The plan is only concerned with Algeria north of the Atlas mountains, it does not include the Sahara, and this might well be considered its most serious default. It aims basically to increase the education of the general population, to improve their housing, and to develop the means of industrial production. It sets itself the aim to create half a million new jobs in five years of which 20% will be in Metropolitan France itself; with an increase of the population of 1·75 million during the existence of the plan, will half a million new jobs be enough if the population is as youthful as it is?

In the agricultural sphere, one-third of Algeria's production is wine; but for a number of reasons it is not proposed in the Plan Constantine to expand this significantly. However, the other agricultural products, namely cereals, fruit, vegetables, and dairy produce, are confidently expected to increase by 40% during the next ten years. Partly this is to be brought about by an improvement of land productivity by the farmers themselves, such as, for example, the extensive planting of olive trees. Here the outstanding example of Borgo a Mozzano in Italy might well help the French agricultural advisers in Algeria. Agricultural progress was there brought about by self-help, raising the population's self-esteem along with its standard of living (DISCOVERY, 1959, vol. 20, No. 8, p. 340).

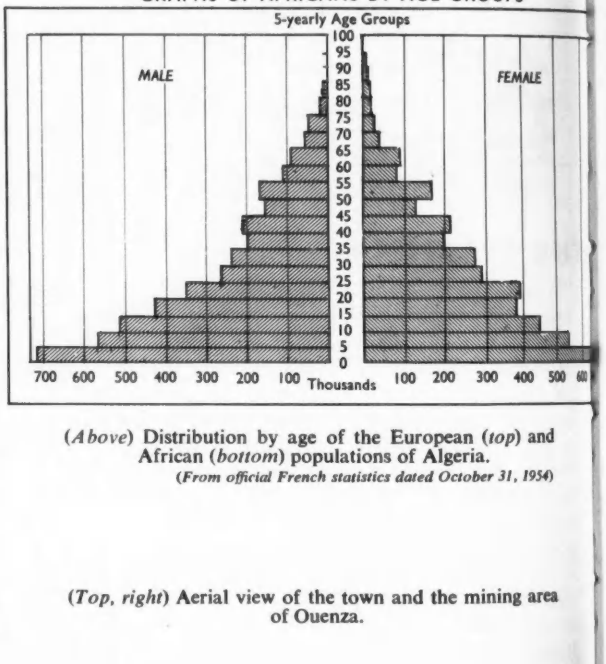
The increased industrial development of Algeria is to be based on the exploitation of its natural resources and a very extensive housing programme. In these considerations, the planners exclude specifically the production of oil and gas in the Sahara itself, as it belongs to a different administrative sector, and because it would artificially inflate the economic structure of Algeria. Instead, iron ores and esparto grass are to be the mainstay, leading to a smelting works at Bône, 500,000 tons annual capacity; perhaps also an oil refinery near Algiers is to be built with particular emphasis on petro-chemicals. But of course it is fully realised that such major basic industries will not create more than about 17,000 new jobs as a maximum. As an example of what has been achieved already, two great pharmaceutical firms in Algiers are quoted, who exported back to France one-third of their total production in 1958. This may well be an indication of the future trends in manufacture. Also, in the view of the planners it is an indication that in the next ten years the whole picture of consumption may well change in Algeria and that completely new markets will arise as the population itself moves upwards in its standard of living. History's epithet of the Plan Constantine may well be: "Too little, too late."

It is in the very nature of economic planning that it must solve the existing problems by already known remedies. This is in contrast to the scientific approach which defines the problems but proceeds to search for new knowledge for their solution. In practice, both economic planning and a scientific approach to the problems of the African continent must go forward together. It is only after thus briefly sketching the population problems of Algeria and their suggested solutions by means of economic planning, that one may legitimately ask about the role of science, pure and applied, in this difficult and not entirely unique picture of an underdeveloped country, trying to achieve an industrial revolution within the space of ten years.

POPULATION OF ALGERIA AT OCTOBER 31, 1954
GRAPHS OF EUROPEANS BY AGE GROUPS



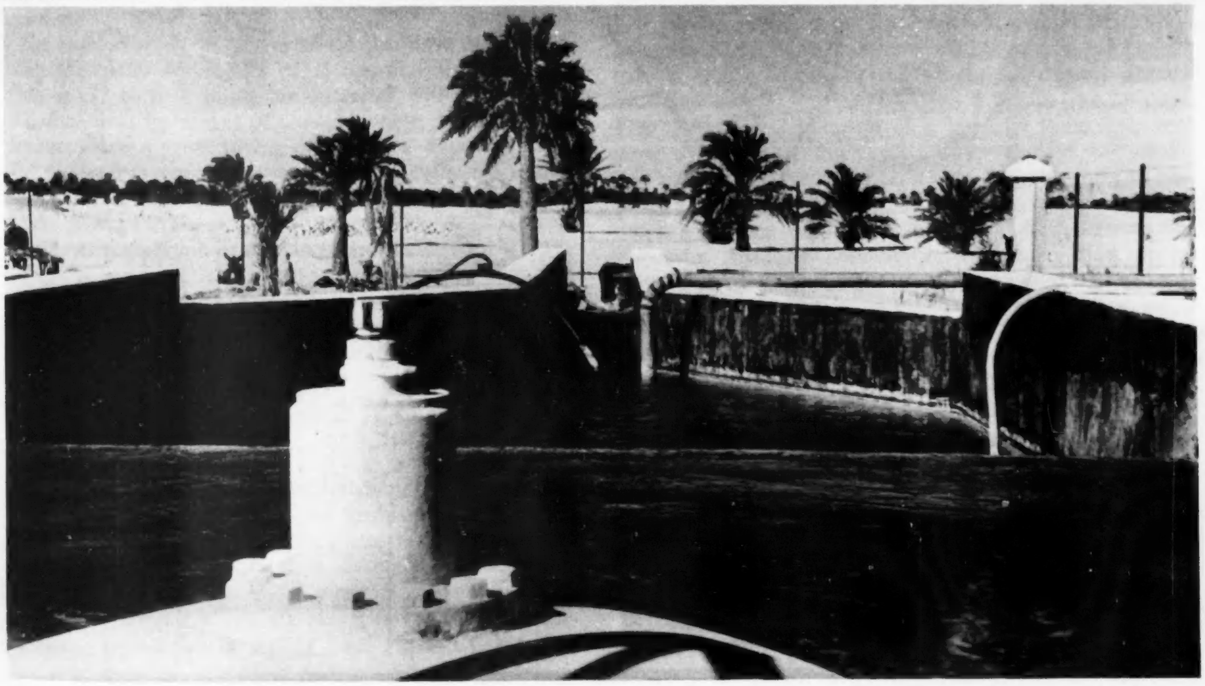
GRAPHS OF AFRICANS BY AGE GROUPS

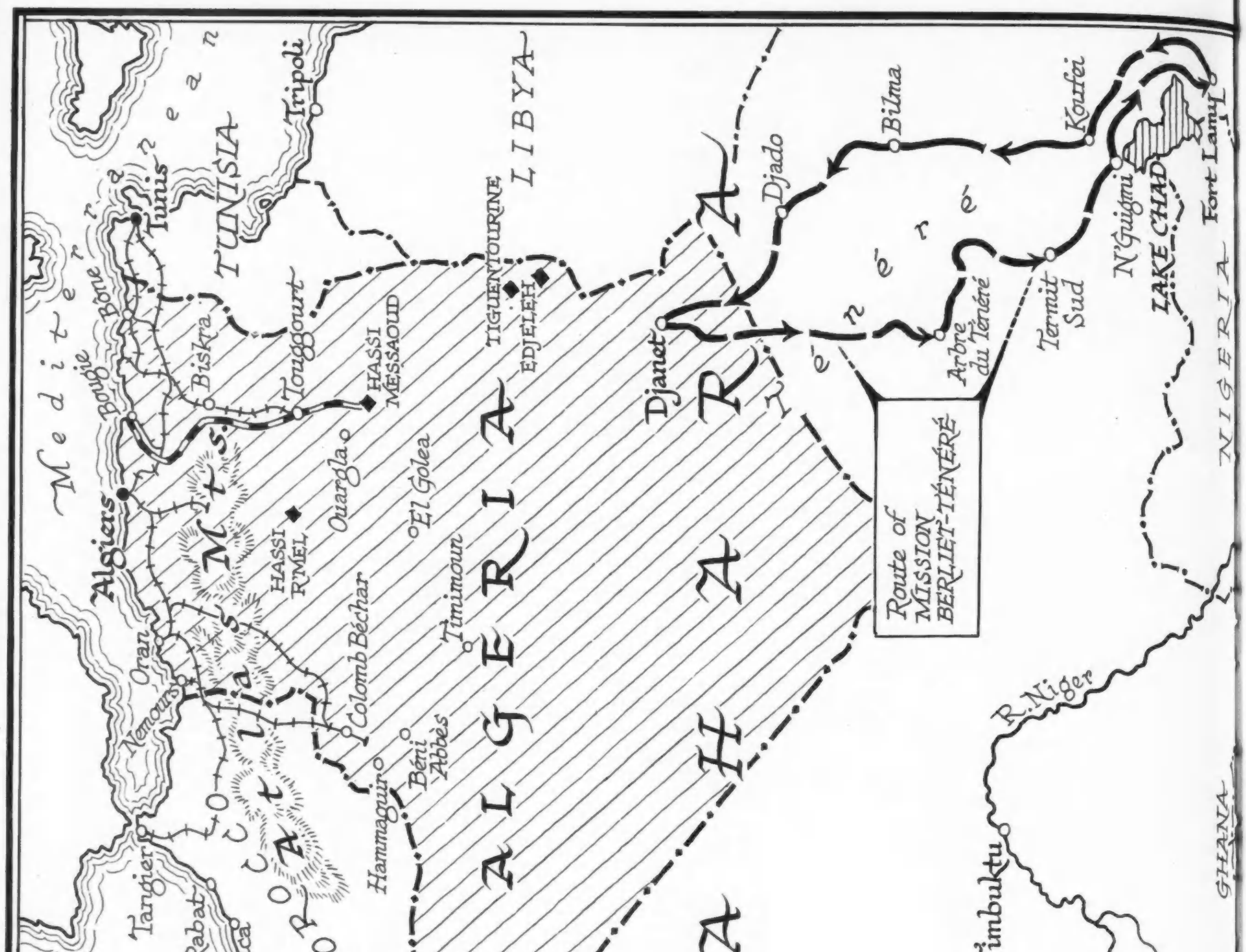


(*Above*) Distribution by age of the European (*top*) and African (*bottom*) populations of Algeria.
(*From official French statistics dated October 31, 1954*)

(*Top, right*) Aerial view of the town and the mining area of Ouenza.

(*Right*) The new artesian well at the Oasis of Ouargla.




Railways
Oil pipe-line
Oil & gas centres
Canary Islands
Port Etienne
PROJECTED RAILWAY
Fort Gouraud
SPANISH
MAURETANIA
Dakar
R. Senegal
Scale of Miles
0
100
300
500
Timbuktu
R. Niger
GHANA
NIGERIA
LAKE CHAD
Fort Lamy
N'Guigmi
Koufei
Termit Sud
Arbre du Ténéré
Bilma
Djado
Djanet
Route of MISSION BERLIET-TÉNÉRÉ
Ténéré
SAHARA
ALGERIA
LIBYA
TUNISIA
Tunis
Tripoli
Mediterranean
Algiers
Bougie
Bone
Biskra
Touggourt
HASSI MESSAOUD
TIGUENTOURINE
EDJELEH
HASSI R'MEL
Ouargla
El Golea
Timimoun
Colomb Béchar
Beni Abbès
Hammaguir
Oran
Nemours
Tangier
Rabat
Casablanca
MOROCCO
Atlas Mts.

THE SCIENTIFIC APPROACH

In general terms, the application of scientific method proceeds from a statement of the problem, via hypotheses, to observation and experiments, and through deduction to conclusion. In the case of North Africa, the basic problem has been outlined above, namely a vast increase of populations, which is not likely to come to a halt within the next few decades. Immediately this problem has been stated, it should be more closely defined in terms of geographical area. Then the dichotomy of over-population north of the Atlas Mountains contrasts strongly with the almost complete absence of human beings south of these mountains, namely in the Sahara proper. Historically this is conditioned through the almost total absence of rain in the Sahara, but to accept this fact as unalterable, and write off the Sahara as unsuitable for human habitation, is completely contrary to the scientific approach.

To begin with, water does exist in the Sahara, admittedly at a depth of about 1000 m. in the Albian stratum. When it was necessary to house 7000 oil drillers at Hassi Messaoud, in the midst of a complete desert area, the water was found in ample quantity and has allowed the establishment of an entirely new township. No doubt, whenever further oil will be found in the Sahara, similar towns will arise where there is at the moment nothing but empty sand dunes and desolate dreariness. Furthermore, wherever there is natural oil and gas, there is an exceedingly ample supply of power, either directly for diesel engines—fortunately the crude oil found at Hassi Messaoud can be used directly without refining—or in the more sophisticated form of electricity. The water from the Albian strata is often very salty, and at present, for example at the Oasis of Ouargla, 4 litres of water have to be used for irrigation, when only 1 litre is used by the plant for its own needs. The remaining 3 litres merely serve to wash away the excess salt.

The ample supply of power could therefore be used to desalt the water by means of electro-dialysis using the resulting salt as a chemical raw material, which can again be decomposed by means of electricity into its constituent elements. Such a great saving of available water, together with the establishment of chemical factories in the desert may not on first investigation appear as a sound commercial proposition in the classical sense of the term. But when the pressure of population in the North and its political consequences is included in this calculation, then faith in the future must be brought in and orthodox financial considerations may well have to be modified.

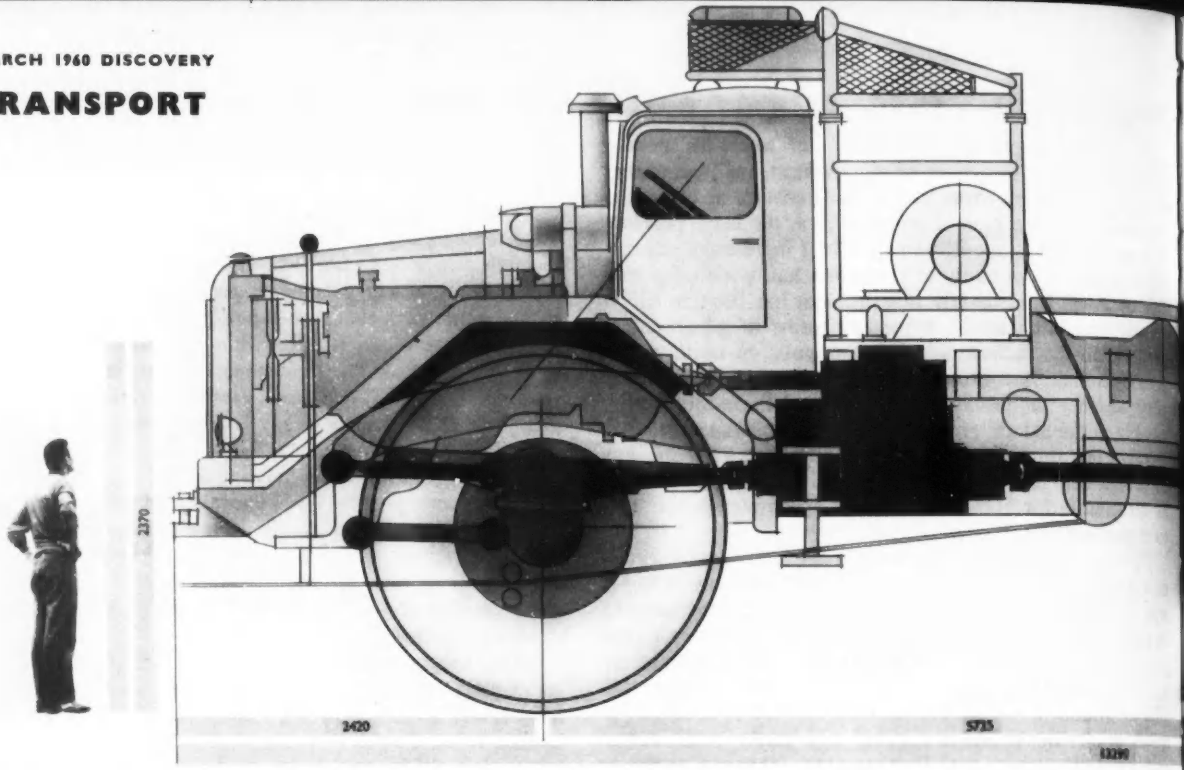
THE EXAMPLE OF THE NEGEV

Such an act of faith is exemplified by the transformed Negev desert in Israel. There the town of Beersheba has arisen during the last few years where there was nothing before except sand dunes and desolation. Water was brought to it through a pipeline hundreds of miles in length (see DISCOVERY, 1959, vol. 20, No. 5, p. 187) and an ever-increasing population is finding new homes when before they were living in camps or had just nowhere to live at all. A comparison of Israel and Algeria is also in other respects revealing. Israel has no resources of power whatsoever, and in order to run its diesel-driven water pumps it must import crude oil from Venezuela—the other side of the Atlantic. The Sahara burns its surplus natural gas in huge torches, and is looking forward to exporting it later through pipelines to far-distant Britain. The population of Israel is extremely heterogeneous, and it is only in the second generation that a common language binds them together. Furthermore, Israel, with a great national deficit, is in an extremely difficult economic situation. And yet in spite of all these difficulties, or perhaps rather because of them, the Battle of the Negev is being won. Besides Beersheba, small settlements, the *kibbutzim*, are springing up in the desert and provide living and home for many thousands of young people. With suitable help, with drilling for water, with the diversion of only a minute fraction of the available power southwards into the Sahara, instead of northwards to the Mediterranean, no doubt an equally great number of young Africans could find a home in the deserts of the Sahara.

When setting out to solve any scientific problem, it is an obvious preliminary to look up the literature on the subject and to discuss it with others who are working along similar lines. One may well ask if the Algerian planners have studied the problems of Israel and other desert-reclamation projects, and if they cannot combine with them in the solution of the common difficulties. Another aspect of water shortage in the desert, namely research on the utilisation of dew, is apparently far more advanced in Israel than in the Sahara (see DISCOVERY, 1957, vol. 18, No. 8, p. 330). On the other hand, research on hydroponics seems more successful at Béni Abbès than in Israel. The scientific experiments and observations made in Israel have already led to many valid deductions and they are surely as applicable to the Sahara as to the Negev. It should be obvious that now, with ample power available at any part of the Sahara which electricity can reach, its natural mineral resources can be exploited. Again a lesson can be cited. The Industrial Revolution of a hundred years ago, took place where ample and cheap power—in that case coal—was near to other mineral resources. Is it too early to plan for the Sahara to become the factory of the whole of Africa? Surely now that it has been learnt that both African and European workmen can do an eight-hour shift in the climate of the Sahara, the first steps could be taken to stop exportation of minerals, and to begin working them up on the site. Then later, perhaps, steel could be rolled into sheets, and finally motor-cars and other finished goods produced where there is only empty sand today. The new markets for these products may well be found south of the Sahara amongst the growing populations of tropical Africa.

The resources required for such an ambitious scheme will be truly gigantic, both in terms of financial investment and in skilled manpower. They may well become available now that hostilities in Algeria have terminated. If only half of the present expenditure on military operations can be continued and be devoted to the peaceful scientific development of the Sahara, a truly satisfying and lasting peace between Africans and Europeans would surely result.

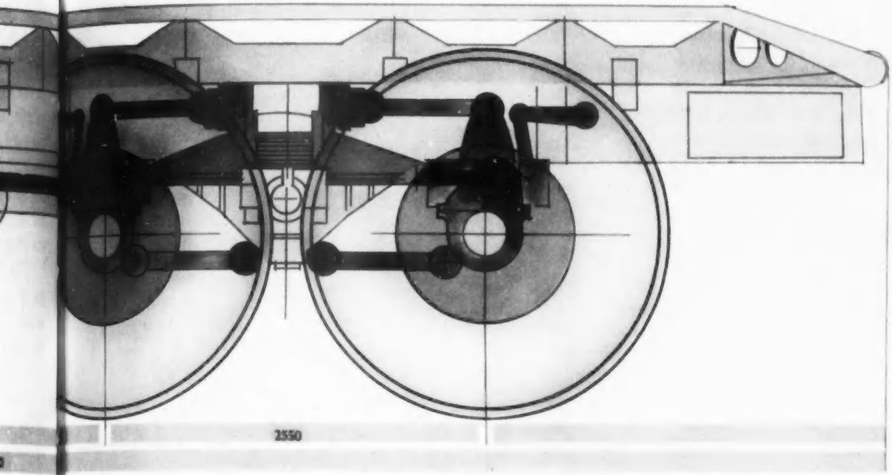
TRANSPORT



If the future of the teeming millions of North Africa lies in the Sahara, then the future of the Sahara depends not only on water, but also on transport. The distances and the isolation are far beyond the imagination of the European, accustomed as he is to find a village every few miles, and a town of considerable size after driving his car for not more than perhaps an hour. The distance from Algiers on the Mediterranean to the Gulf of Guinea is 2100 miles, a flight of 6¼ hours in the Caravelle, a jet plane averaging 340 miles per hour. During such a flight no more than perhaps three or four oases, of a few houses each, would be seen. The aircraft, then, is an obvious means of transport for the Sahara, when valuable and small cargo needs to be carried. For bulk transport of liquids, like crude oil and water, the pipe-line provides the solution, whereas for the carriage of bulky and heavy goods, ground transport by Land-Rover or heavy goods truck, is the only possibility. With one or two exceptions, like coal and iron ore, the railway is not likely to solve the transport problems of the Sahara.

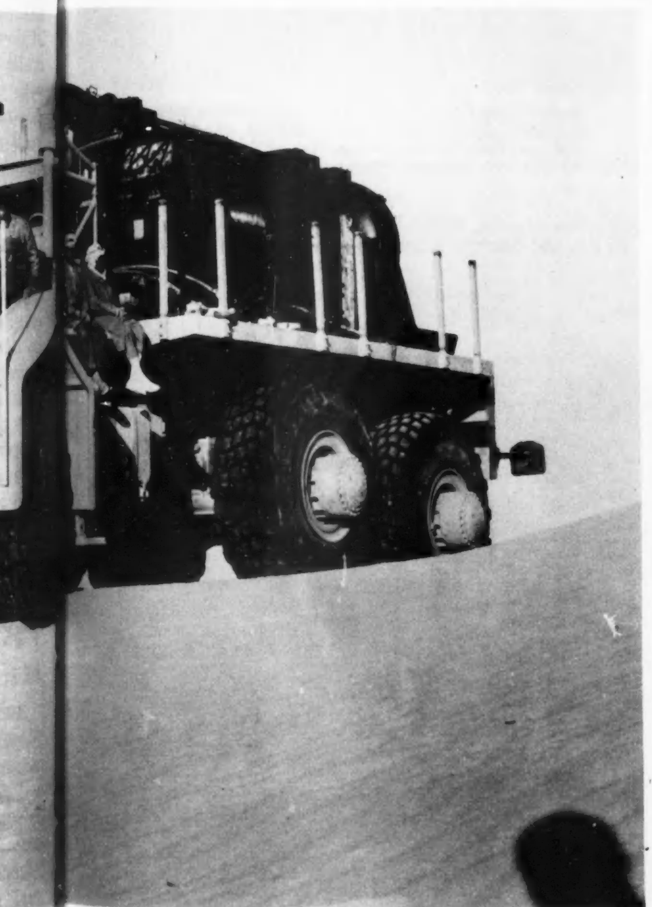
As an example of the use of aircraft in the opening-up of the Sahara, the laying of the pipeline from Hassi Messaoud to Bougie on the Mediterranean coast, a distance of 435 miles, may be quoted: The speed of laying the 24-in. pipe was 2–2½ miles per day, and although the pipe sections themselves were brought to the site by rail and heavy truck, all the auxiliary transport was carried out by aircraft. The complete food and water supplies for the teams of workmen, the relief shifts, spares, tools, and all other equipment reached the men on the spot by Air France Dakotas, DC-3, by Skymasters, DC-4, or by Breguet double-decker cargo planes. These relatively small machines had to be used on rudimentary air-strips, hastily levelled and marked out as the work itself advanced.

Apart from this spectacular air-lift, hundreds of daily



(*Left*) Diagram of the giant Berliet T100 showing its six-wheel drive and winch. (All measurements are in millimetres.)

(*Below, centre*) The T100 transporting one of the winches used on an oil-drilling rig across the open Sahara Desert.



routine flights are made to isolated prospecting teams, and to distant oases, bringing them not only the necessities for survival, but also some of the luxuries of life which make the difference between existence and efficient working under extreme climatic conditions. Air France and its associated transport companies can therefore legitimately claim to have played an essential role in the development of the Sahara.

Transport on land falls into two distinct categories, the moving of personnel and the movement of heavy goods. Where, often, men have to travel to the working site 20 miles from their camp, where exploration is carried out on the top of an iron-ore hill, where an army convoy is led to the recovery of a guided missile across the open desert, only the ubiquitous Land-Rover can provide the answer. This is, incidentally, the only British contribution to the development of the Sahara. All models, from the earliest made in 1948, to the latest Mark II with tropical roofing, can be seen in very large numbers in all parts of the Sahara; the only modification carried out on the standard model is the fitting of extra-large balloon tyres for the negotiation of loose sand.

For the transport of heavy goods the French firm of Berliet has provided the majority of vehicles. Perhaps its most astonishing contribution is its model T100, the largest truck in the world. Powered by a V-12 600 h.p. diesel engine of 30 litres capacity, it is 40 ft. long, and its front wheels are 7 ft. 3 in. high; its total weight is 90 tons, and although only six prototypes have been built so far, they have already been of very great value for the transport of complete oil-drilling rigs across open desert. The use of extremely large tyres has resulted in a weight ground-area ratio which is said to be lower than that of the camel. It is likely that this giant vehicle will be seen at the next London Commercial Vehicle show.

MISSION BERLIET-TÉNÉRÉ

The use of land vehicles for purely scientific exploration dates back in Africa to the half-track Citroën cars which traversed the whole continent from Oran to Madagascar in 1924 led by Haardt and Audouin-Dubreuil. From them arose, not many years later, a regular transport service with six-wheeled passenger cars from oasis to oasis. Now again an exploration is carried out by a French car firm, the Mission Berliet-Ténéré. Nine Berliet "Gaselles" (5-cylinder diesel engines, 8-litre capacity, 150 h.p., six-wheel drive) painted in the colours of the rainbow to indicate their loads and function, together with five Land-Rovers and an air-support of one Dakota and a helicopter, left Djanet in the middle of November 1959 and reached Fort Lamy, on Lake Chad, slightly less than a month later, having covered a distance of over 800 miles. They travelled across uncharted desert, never before traversed by any vehicle. Their return journey was equally smooth, and thus they achieved one of their aims, namely to show that this completely explored route is open for the transport of heavy goods.

Their second aim is one of purely scientific exploration and the presence of Profs Capot-Rey and Monod, as well as Dr Borrey and Mr Henri Lhote—the discoverer of the prehistoric paintings in the Sahara—should lead to rich material for subsequent evaluation. One of the remarkable feats of the expedition has been their daily progress reports from the Sahara by means of radio link; another, the discovery of quartz "pebble-tools" dating back 600,000 years, and thus being one of the most ancient examples of human tools. From the preliminary reports it appears that, as the central lake which covered the whole area of Ténéré receded, prehistoric man followed its ebbing shores. Numerous other archaeological, botanical, and even some zoological, finds should certainly make this expedition a historic event in the transport annals of the Sahara.

In the 1920s Renault started a regular service between the northern oases in the Sahara, with six-wheeled vehicles. One of these is here seen in an awkward position between El-Oued and Tozeur.

(From a contemporary postcard)

The Mission Berliet-Ténéré during a temporary halt in the desert to receive supplies from a DC-3 Dakota.

The Mission Berliet-Ténéré crossing the eastern part of the Grand Erg.

One of the archaeologists on the expedition digging out a prehistoric pot.

EDUCATION

Education below university level in Algeria is divided into three parts: Primary, secondary-classical, and modern. Although, theoretically, both Africans and Europeans have the same rights to all three, statistics show that at present twice as many African children benefit from primary education as European children, that in secondary education the ratio is reversed, the number of Europeans being four times that of Africans, and that finally at university level, the number of African students is still quite small. No doubt in years to come, this trend will be changed as the children now benefiting from primary education grow up, and they will also go to the university. Indeed, this is the very aim of many forward-looking members of the university staff. In pure research, the role of Africans is still that of the technician, although again it is the aim to invite them to participate far more actively in scientific laboratory work than they have done so far.

The University of Algiers celebrated its fiftieth anniversary in December 1959, being the youngest, and in number of students the tenth of all French universities. Fifty years ago it had 129 students; in 1957 there were 2156 students in the faculties of science, medicine, and pharmacy; in 1958 the number had increased to 2772 and for the present academic year it stands at 2863.

It appears likely that the number of European students of Algerian origin, who study now in Metropolitan French universities, will have risen in the last few years, owing to the unsettled political situation. How real this problem is, was shown on the day of the university anniversary celebrations, when a young European student, Paul-René Couderc, was killed by a bomb at the entrance to the university. This stupid act of terrorism must be condemned by all to whom the word university still means a place of education for all mankind.

THE INSTITUTE OF NUCLEAR RESEARCH

As an integral part of the university anniversary celebrations, this latest research institute was opened. Equipped with a 3 MeV van de Graaff accelerator and a number of other important pieces of equipment, it is hoped in the first years of its work to study purely nuclear reactions, the effect of radiation on semi-conductors, and finally electronic research in its relationship to nuclear physics. The director of the Institute, Prof. A. Blanc-Lapierre, sees the role of his Institute as contributing to basic new knowledge in selected fields of nuclear physics and also as a training school for technicians and research workers in the subjects of high-vacuum and electronics. His beautiful modern Institute will no doubt attract in the years to come many African and European students, anxious to fulfil the two aims of its directors.

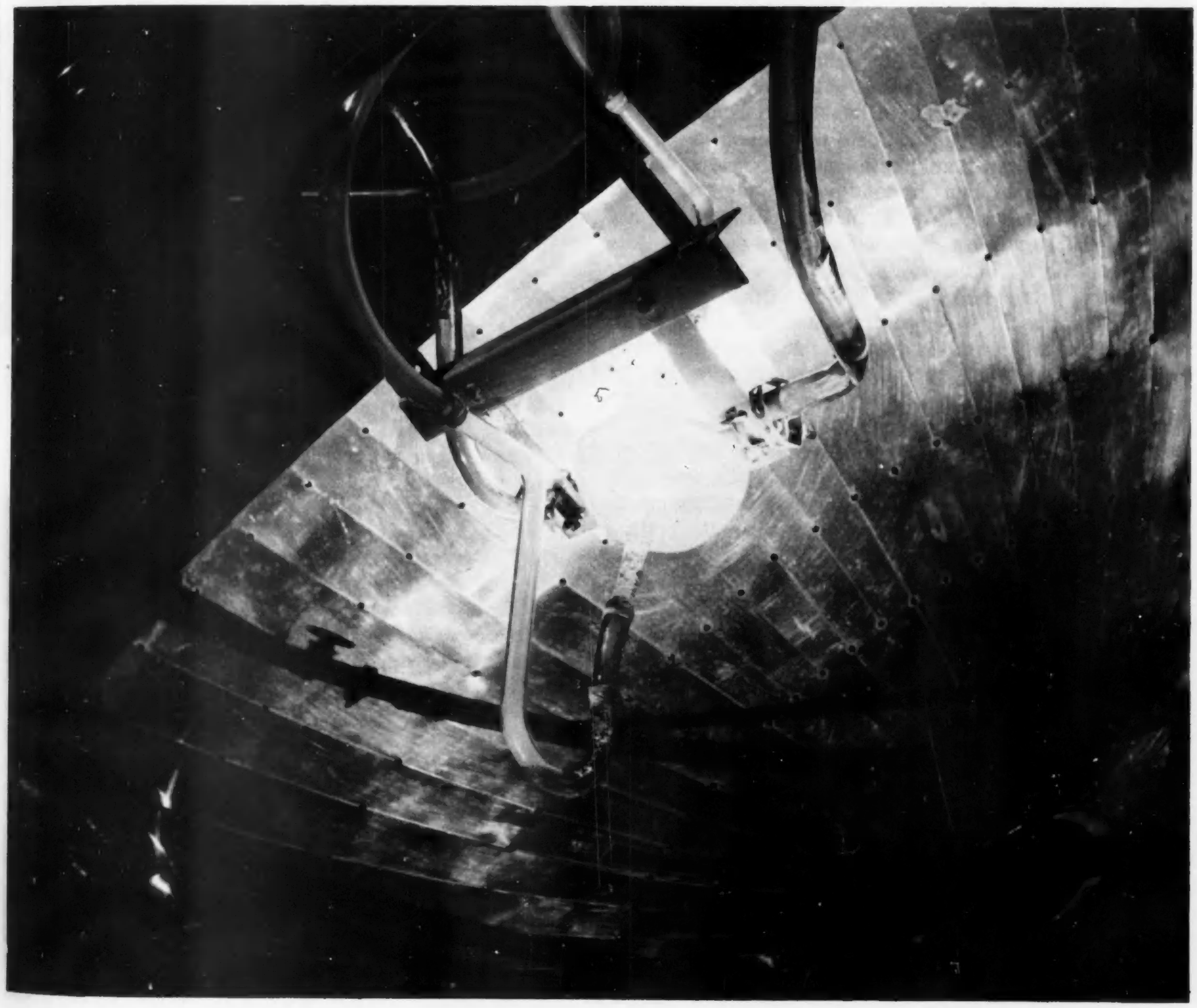
The Institute of Nuclear Research of the University of Algiers.

THE SOLAR FURNACE AT BOUZARÉAH

Unlike the solar furnace at Montlouis, in the French Pyrenees, where a plane mirror rotates to follow the diurnal movement of the Earth and reflects the light into a stationary parabolic mirror, the solar furnace at Bouzaréah, about 20 km. away from Algiers, has only one, rotating parabolic mirror. It is mounted in truly astronomical bearings, allowing for alignment in azimuth and declination; once focused, it automatically follows the apparent movements of the Sun. Again unlike the Montlouis furnace, its object is to concentrate a narrow band of the spectrum, namely the ultra-violet, on to a small chemical reaction flask at its focus; there a number of highly interesting research problems have already been investigated. The parabolic mirror is composed of 144 segments, made from electrolytically polished aluminium sheeting, which have remained in perfect reflective condition for several years. The diameter of the mirror is 8·4 m., giving a reflective surface of 50 sq. m., and thus concentrating 40 kW on its focus at a temperature of 3000°C.

At the focus a filter has been constructed to remove all but the ultra-violet radiation, and this has been achieved by two concentric Perspex spheres, between which a solution of mixed copper and cobalt sulphates circulates, absorbing all radiation above 4000 Å. One thousand watts of pure ultra-violet energy are thus focused on to the reaction vessel, a quartz sphere of 6 cm. diameter. Chlorinations, nitrations, and the cracking of hydrocarbons have been studied, for example the synthesis of nitric acid. When a mixture of nitrogen and oxygen is passed over a thorium oxide catalyst at 3000°C at the focus of the furnace, various oxides of nitrogen are formed which can be stabilised by quenching them in caustic soda solution; 20 gm. of nitric acid per sq. m. of reflector have been obtained per hour. The cracking of hydrocarbons has been carried out by means of a uranium oxide catalyst, yielding greater amounts of acetylene and light fractions than with conventional cracking procedures. This extremely powerful and unique research instrument may well be destined to advance considerably our knowledge of chemical reaction kinetics.

One of the reaction vessels at the focus of the parabolic mirror.



PHYSIOLOGY AND PSYCHOLOGY

PROHUZA are the initials of a French committee established to study human problems in arid zones (Problèmes humaines des zones arides). One of its most prominent members is Dr Vigan, a medical specialist and consultant to several of the oil-exploration companies in the Sahara. Right from the beginning of the oil exploration work, great concern was felt about asking European workers to perform heavy manual work under the extreme climatic conditions of the Sahara, with temperatures up to 125°F and humidity of less than 15%. About half of the European oil workers came from Algeria, the remainder from various other European countries. At the beginning, back in 1953, it was customary to work for three weeks in the Sahara, then rest for one week in Algeria, the company paying air travel both ways. But it was soon discovered that one week's rest was insufficient and therefore most workers prefer now to work for six and rest for two weeks. The fatigue experienced by these European workers has been extreme, and tests carried out by Dr Vigan reached figures heretofore unknown; on a scale where 3·5 represents the fatigue of a runner at the end of a 100-yd. sprint, the oil workers recorded 7. PROHUZA has carried out extensive physiological tests on a representative group of thirty-five subjects, with daily records of pulse rate, temperatures, blood pressure, food and liquid intake, and excretion. The results, analysed by a punched-card technique showed that there were no short-term physiological or psychological problems, provided that air-conditioned lodgings, ample rest, and first-class food was available. It is, perhaps, not surprising that food has presented a special problem of its own. Oil drilling continues for 24 hours a day, in three eight-hour shifts, whether the drill is worked in Alaska or in the Sahara. Shifts are naturally rotated, and an eight-hour sleep period is mandatory. But the French European workers have not been willing to give up their normal routine of starting a morning shift with nothing more than a cup of coffee, which is followed after four hours of hard work by a mere *casse-croute*. Dr Vigan is hoping to persuade them to eat a substantial English breakfast before the beginning of their shift, although other attempts to persuade the men to adopt a special summer diet of lean meat and boiled vegetables have so far proved completely fruitless. Any suggestions of change from the normal metropolitan French diet met with talk of strikes, and had, therefore, to be abandoned.

Liquid intake has been easier to resolve. During the summer months, heavy manual work leads to a total daily loss of ten to fifteen litres of water, at an hourly rate of one litre; this liquid has to be replaced, and the normal intake of fluids consists mostly of fruit juices, water flavoured with syrup and with lemon. The well-known symptoms of "colonial liver", such as light jaundice, colitis, vomiting and so forth, may well have their origin in this necessarily extreme demand on the liver which shows itself in Europeans in the Sahara after about two years' heavy manual work. To study the details of adaptation in Europeans, the relevancy of the sodium-potassium balance in sweat and liquid intake, to evaluate ergometer performance, and an extension of the same research to

An African engaged in a test to determine his manual dexterity. The object is to move the annular discs from the right pile to the left pile in the minimum time.

African workers, are only some of the physiological research projects of the future.

But also in the psychological field, PROHUZA has carried out some extremely valuable preliminary work. The first investigation was concerned with the high labour turn-over which occurred. This was by no means entirely due to the physical hardships; detailed questioning of the workmen about their previous employment, their family status, their financial commitments and so forth, showed that a great many of them had a history of mental instability and that their motivation for working in the Sahara was often of questionable origin. Perhaps they might be called a "Foreign Legion of Technicians". Careful sifting of applicants has now removed most of the lesser suited workmen, although the best psychological criteria for work in the Sahara are by no means yet established. Perhaps the setting up of married quarters, a plan for the not-too-distant future, may help in this respect.

PROHUZA's work on African labour has by no means proved easy. For many tasks, completely new batteries of tests, both of skill and of psychological aptitude, had to be developed, as the established tests, like the Rorschach, for

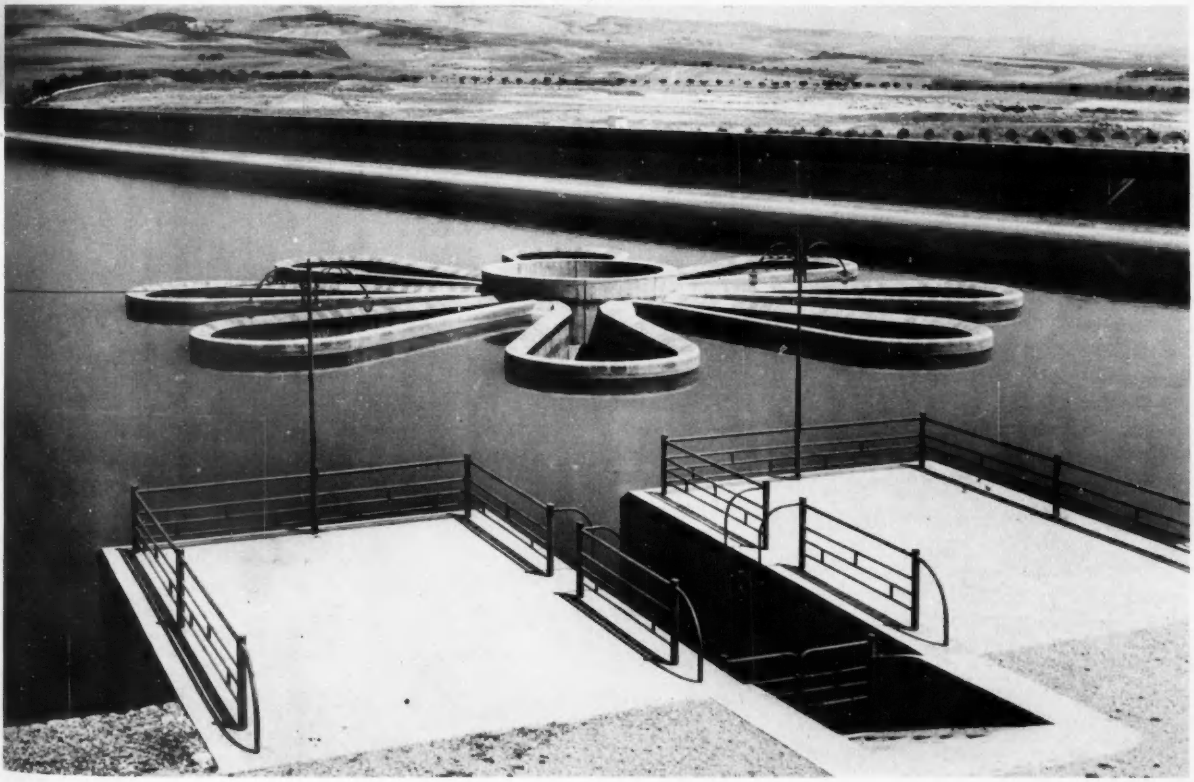
example, produced useless results. The giving of the new tests led also to difficulties, as the offer of good jobs was held out as an incentive; the first subjects always tested well, but as soon as the later subjects saw that a good job did not immediately follow the end of the test, their performance fell considerably. The social stratification amongst Africans, ranging from nobles to slaves, has superimposed further psychological difficulties, as their tradition and their upbringing has made them to consider certain jobs as taboo. One can only hope that a complete use of all available modern knowledge—which is by no means extensive yet—can further the important work of PROHUZA and thus give to the many thousands that are working in the Sahara a satisfying and rewarding employment, even under the hardest climatic conditions. Apparently, past military experience has been negligible in the medical field, even for members of the Foreign Legion, and has not helped PROHUZA.

RESEARCH AT CLAIRBOIS

In about 1947, a central Water Research Institute was established at Clairbois, one of Algiers' suburbs. A team of hydrologists, climatologists, chemists, physicists, geologists, soil engineers, and statisticians is now at work to study the many different aspects of water as they affect Algeria and the Sahara. Naturally the first step has been to chart, as accurately as possible, the water balance, and to record with the greatest detail possible, the rainfall, evaporation, run-off, and ground absorption of water. Many rain gauges have been set up for this purpose, thousands of water analyses are made yearly, and this large accumulation of data is recorded at the Institute in extensive card indexes. The Institute is, in fact, more a data-collecting centre than a body of scientists initiating research.

Yet, in spite of their painstaking work, no complete water survey of this region of North Africa is available. A great deal of knowledge is still needed to plot the water level accurately, and in spite of the recent publicity given to the Albian stratum, much more research is required before one can speak of even beginning to "irrigate the Sahara". The Albian stratum, lying at a depth of 1000 m. below ground level, runs southward from the Atlas Mountains and although its existence had been suspected for several decades, it has been confirmed finally only as a by-product of the drilling for oil. Plans are now being discussed of sinking a dozen deep artesian wells and tapping this stratum at a rate of 30 cu. m./sec. (16 million gallons/hr.). Unfortunately, the water from the Albian stratum is often extremely salty, 1 gm./litre, (10,000 parts per million) and needs desalting before it can be of extensive use. This is an economic question, depending on the cost of power and electricity at the site of any new planned oasis. Although it may be possible to desalt small quantities of water, this cannot yet be done on a large scale. Above all else, the staff of the Clairbois Institute is most anxious that no more water is taken from their natural reserve than is replenished by the annual rainfall.

The water reservoir at Oued Sarno. The water overflow, built in the shape of a star, is seen in the background.

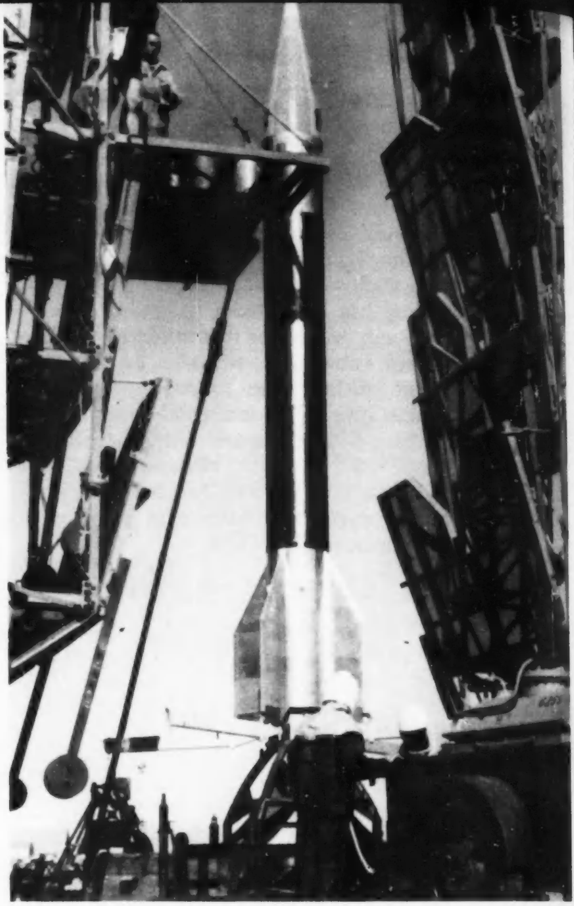


MISSILE RESEARCH AT COLOMB BÉCHAR

Colomb Béchar is a small town, the terminal of two railways linking it with Oran and Nemours on the Mediterranean. The railways were constructed originally to transport coal from the nearby mines to the Algerian centres of population in the north, but when the French armed services decided in 1947 to establish a missiles research centre in the Sahara, the existence of these two railways was, no doubt, decisive in choosing Colomb Béchar. Right from the beginning all missile testing was carried out jointly by the Army and the Air Force, the French Navy apparently preferring its own research station on an island off the coast of France.

The conditions for missile research are relatively good in the Sahara because of its large uninhabited areas and the flat nature of the ground, which greatly facilitates the recovery of missiles. The excellent light and the purity of the air makes photographic and cinematographic recording relatively simple, if the hours of darkness and very early morning are used; otherwise the heat turbulence of the air, once the sun has risen, presents difficulties. Against these advantages, the climatic conditions of the area can be very trying with sand-storms of 100 m.p.h., and maximum temperatures in the summer of 110°F. The average rainfall is about two inches a year. The women and children of the scientific and army personnel leave the centre on May 1 each year and between June 15 and September 15 the range closes down. An annual holiday of 45 days is granted to all male personnel.

In the early days, the missiles range began a mere 10 km. from the centre of the town, but it has now been shifted to Hammaguir, about 100 km. to the south-west of Colomb Béchar. From there an 800-km. range in a south-westerly direction was first used, but being too close to the Moroccan frontier, its direction has now been changed to south-east. As far as it is known, the missiles being tested at present fall into the four conventional groups of ground-to-ground, ground-to-air, air-to-ground, and air-to-air. A large-scale extension of the Hammaguir range in a south-easterly direction is envisaged for the future, giving it an effective distance of 3000 km. to Lake Chad, and even beyond, of 4500 km. into the Indian Ocean. A design-study group of French aviation firms has recently been set up to evaluate the construction of long-range missiles, which will then presumably be tested on the extended range. The emphasis of French missile work appears to be an exact recording of missile trajectories for which Askania and Contraves cine-theodolites are employed; the evaluation of the resulting films is carried out with the American Benson-Lehner semi-automatic plotter.

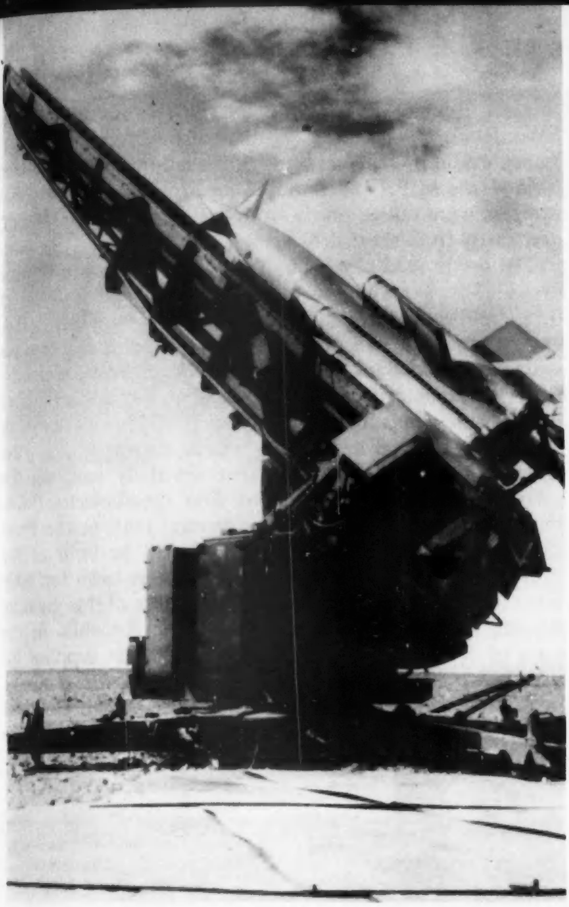


(*Above*) VERONIQUE. This is a single-stage liquid-propellent research vehicle, which has been in use for some years. A unique feature is that it is wire-guided for about the first 200 ft. of its vertical trajectory by means of wires attached to jettisonable cruciform arms under its tail fins. Instruments are carried in an 0·13 m.³ nose compartment, which is separated by a time-switch and can be recovered. The latest version is designed to reach an altitude of at least 125 miles, carrying 130 lb. of instruments.

Length, 24 ft.; diameter, 30 in.; fin span, 4 ft. 5 in.; launching weight, 2955 lb.; speed at burn-out, 4250 m.p.h.

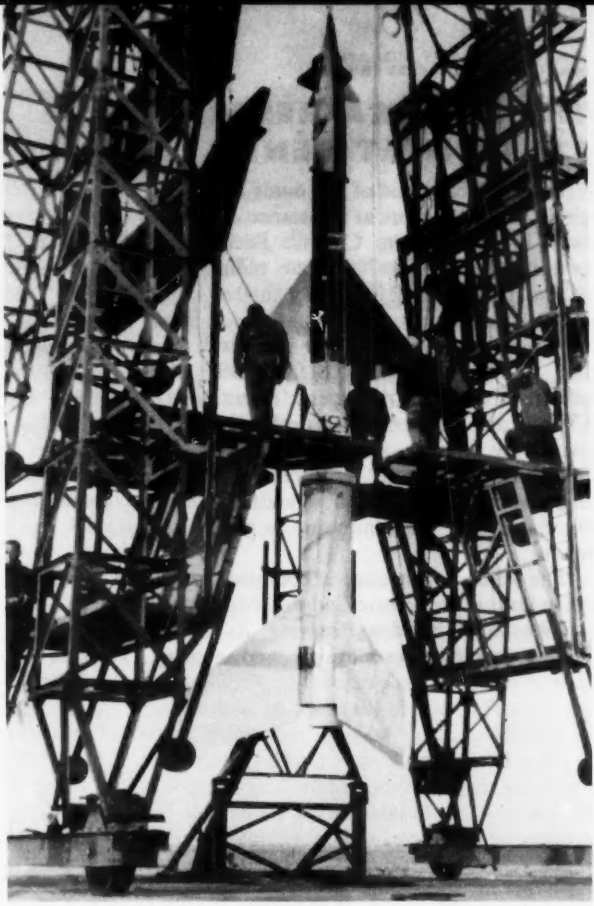
S.E. 4200, manufactured by Sud-Aviation. A "flying bomb" bombardment weapon in limited service with French Army. Power unit is an integral ram-jet in the fuselage, fed by kerosene fuel from internal tanks. The missile is launched from a short ramp with the aid of two solid-propellent jettisonable boosters. In flight, it is stabilised by a gyroscopic system through wing-tip rudders and trailing-edge elevons. A sensitive altimeter keeps it at a pre-determined cruising height. Its position is telemetered back to a controller, who can cause it to dive into the target by radio signal. The high-explosive charge is carried in an under-fuselage streamlined pod.

Length (without boosters), about 10 ft.; wing span, 7 ft. 1 in.; launching weight, 660 lb.; range, about 62 miles at high subsonic speed.



PARCA (Projectile Autopropulsé Radioguidé Contre Avions). First operational French anti-aircraft guided missile, used mainly for training. Ramp is aimed automatically in direction of target by radar. The missile has a solid-propellent sustainer and is launched with the aid of four jettisonable solid-propellent boosters. Angular co-ordinates of missile and target are tracked continuously by radar direction-finders, and the two are brought together by radar command guidance. The high-explosive warhead has a proximity fuse. Wings are fixed, the missile being "steered" by movable fore-planes.

Length, about 18 ft.; wing span, 5 ft. 3 in.; launching weight, about a ton; speed at burn-out, 1100 m.p.h.; ceiling, 82,000 ft.; range, nearly 9 miles.

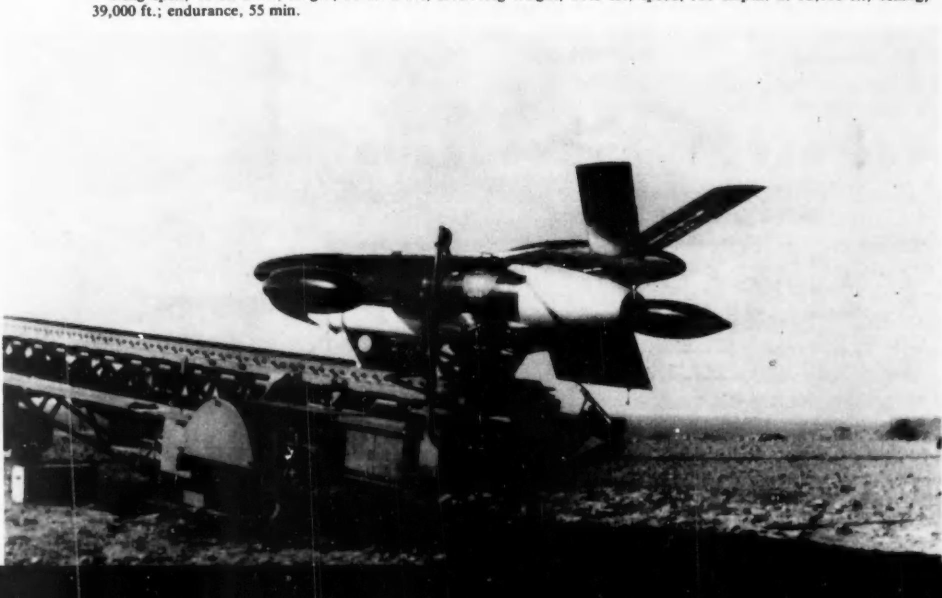


MATRA R.422-B, manufactured by Société Générale de Mécanique. Aviation Traction. Anti-aircraft guided weapon capable of dealing with aircraft flying at up to Mach 1. Under development since 1954. Production design finalised in 1957 and tests now concentrated on perfecting guidance and homing systems. Tandem two-stage solid-propellent missile, both stages firing together at take-off (hollow thrust casing between stages). Booster stage jettisons after burn-out. Radar command guidance similar in principle to that of *Parca*, with electromagnetic terminal homing. 110-lb. high-explosive warhead with electromagnetic proximity fuse. Fore-plane control surfaces, fixed wings. Can be fired from mobile transporter-launcher.

Length, 30 ft. 8 in.; diameter, 16 in.; wing span, 6 ft. 7 in.; launching weight, 3525 lb.; speed at burn-out, 1700 m.p.h.; slant range, 31 miles; interception limits 26,000–59,000 ft.

(*Below*) NORD CT.20. This is a radio-controlled target for fighter and anti-aircraft missile firing practice, of which 350 are being supplied to the French services. It is, in effect, a small aeroplane, powered by an 880-lb.s.t. Turboméca Marboré II turbojet (inside the fuselage) and ramp-launched with the aid of two solid-propellent rockets which remain attached to the launching carriage. It is radio-controlled either from the ground or from an aircraft and is recovered by parachute at the end of its flight.

Wing span, 11 ft. 2 in.; length, 17 ft. 8 in.; launching weight, 1445 lb.; speed, 560 m.p.h. at 32,000 ft.; ceiling, 39,000 ft.; endurance, 55 min.



THE SAHARA RESEARCH STATION AT BÉNI ABBÈS

Béni Abbès is one of the oases which stretch in a semi-circle around Algiers at a distance of about 600 miles. It is only 150 miles from Colomb Béchar, and with its own swimming-pool and 7000 date palms, it is, perhaps, one of the most typical of these ancient outposts of man in the Sahara. Its choice as a station for desert research was, therefore, a most suitable one and it is due to M. Menchikoff that it has come into existence. Officially it is a station of the French Government Scientific Department, the CNRS, and was officially declared open in 1943. However, only after the end of World War II, in 1950, has it been able to go ahead with its aim of "initiating, supporting, and carrying out all scientific researches concerning the Sahara." After nine years, a good beginning has been made.

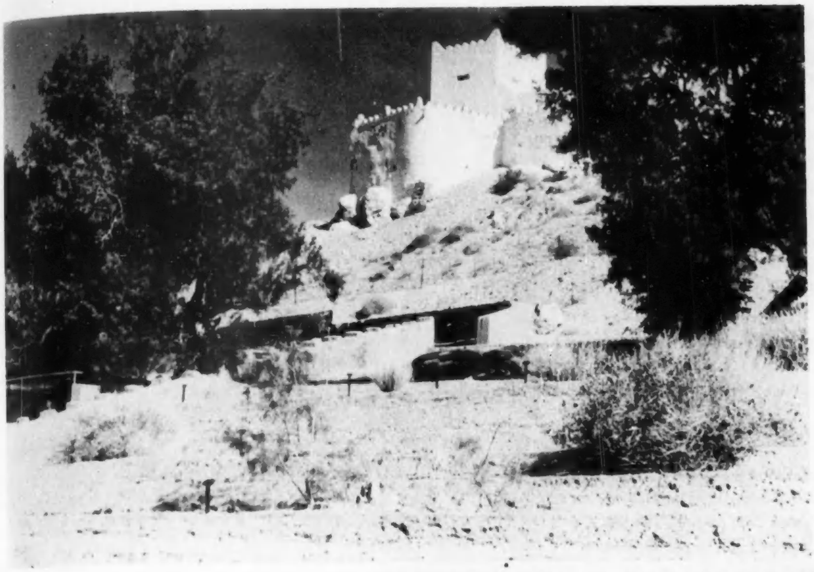
The station comprises a botanical garden, a zoological collection, a prehistoric and anthropological museum, and a laboratory building, serving its main disciplines of botany, zoology, geophysics, and geology. Perhaps the most significant piece of botanical research at present is the work carried out in the field of hydroponics; by using a minimum of soil together with a minimum of nutrient solution in a small, and almost water-tight, flower bed, excellent results have been obtained. Zoological research has been concentrated on the rodents of the Sahara, their ecology and morphology, on locusts, and on a survey of the general fauna of the Sahara. Geophysical studies have been mainly concerned with dunes, their formation and movements, desert winds and their effect on dunes, and finally terrestrial magnetism, partly carried out in collaboration with the missile teams at Colomb Béchar. In the field of geology, the most significant event was the publication of the geological map of the Sahara, scale 1 : 2,000,000, in 1952, which has now been followed by several sheets of a similar map, scale 1 : 500,000.

In the past, the station at Béni Abbès has provided much hospitality to visiting French and foreign scientists who have used it as a base for their special expeditions. In the future the staff of the station hopes that this will be much expanded, that Béni Abbès will become the centre of the geological service of the Sahara, and that under its guidance, other similar stations will be opened in other parts of the Sahara, as they became more fully explored. One can only pray that for such vital work the fullest possible financial support will be forthcoming from private and government resources.

IRON ORE AT FORT GOURAUD

Fort Gouraud is a small army fort in the independent Islamic Republic of Mauretania, one of the most recent members of the French Commonwealth. Geographically it is situated in the western part of the Sahara, 200 miles from the coast, 250 miles from its nearest neighbour fort, and 1360 miles from the nearest town, Casablanca, in the north. It is, indeed, a lonely and extremely isolated place and if it were not for the presence of iron-ore hills near by, few people outside its walls would ever have heard of it. The existence of extremely rich iron-ore deposits was brought to light during the 1934 geological survey when the fort itself was established, but only within recent years have detailed plans been formulated for their mining and transportation to the coast. An international company was formed, the MIFERMA, and up to the end of 1959, 10,000 samples were taken, partly from the surface of the massif, and partly from short drill holes.

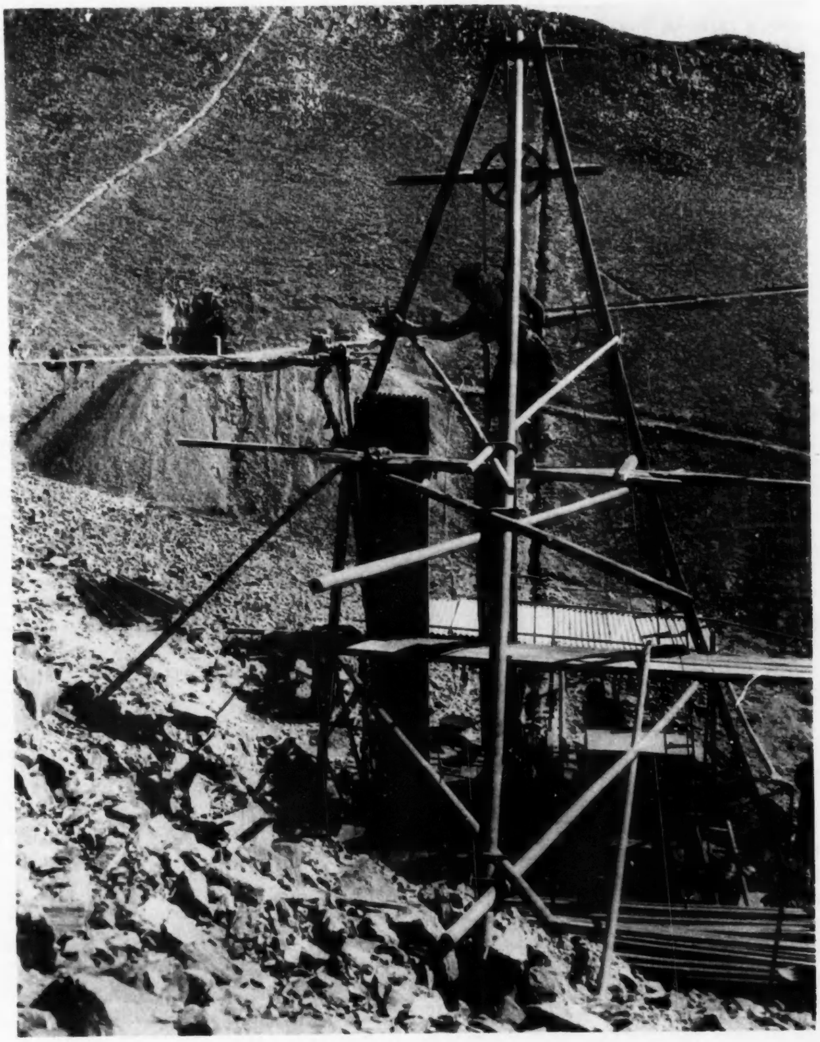
The ore proved of excellent quality with an iron content of 63–67%, a maximum of 8% silica, phosphorus about 0·5%, manganese 0·5%, and water below 1%. The reserves are estimated at 215 million tons, and if the negotiations with the World Bank, now in an advanced stage, are satisfactorily concluded, then it is hoped to move 10,000 tons daily to the coast from the beginning of 1963 onwards. A railway, about 400 miles long, will be constructed to Port Etienne, and it is envisaged that the daily load can be carried in one train, hauled by four diesel-electric locomotives, but only needing two drivers, both in the front cabin. Storage and loading facilities will be built at the Port to handle ships of 60,000 tons, a new town for 4000 inhabitants will be erected, and the profits of this gigantic scheme will be shared with the Islamic Republic in the ratio of 50 : 50. Most important of all, water supplies for the site are assured by deep drilling, and therefore a mining town of about 6000 inhabitants will arise at Fort Gouraud where, today, the total inhabitants of the huts around the fort number no more than perhaps 250.



The botanical garden at the Béni Abbès Research Station showing, in the foreground, the natural vegetation of the surrounding Sahara district (not irrigated) and, in the background, the army fort, and, right and left, trees which have been intensively irrigated.

(*Left*) A nomad family near Fort Gouraud.

(*Right*) Drilling for a core sample in the iron-ore deposits of Tazadit near Fort Gouraud. In the background, the entrance to a horizontal exploratory shaft which has been sunk in order to obtain samples from the inside of the mountain.



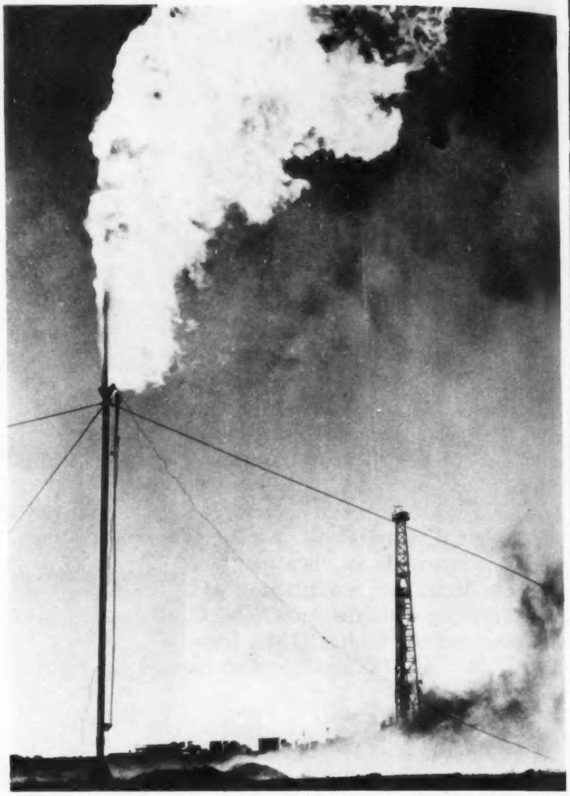
OIL AND GAS IN THE SAHARA

Exactly four years ago, in January 1956, Hassi Messaoud, meaning the "Happy Well", was but one single water-hole in the Sahara, surrounded by a ten-foot-high wall and covered by a dome-shaped roof. Today, a twenty-four-inch pipeline, 400 miles long, links this most recently discovered oilfield to the Mediterranean coast. It is expected that through this pipeline, 9 million tons of crude oil will flow during 1960 and that a year later this will be increased to 13 million tons. This represents 60% of the total oil consumption of France. But there is undoubtedly much more to come, and drilling goes on day and night to delimit accurately the extent of the oil strike and to estimate the total reserves, so far put tentatively at 500 million tons. These figures mean perhaps little, unless understood in relation to the world oil consumption.

At the beginning of 1959, the total world consumption of oil was 805 million tons per annum, excluding the countries behind the Iron Curtain. The U.S.A. and Canada alone consumed 190 million and thus had the highest ratio per member of their population, namely 2·43 tons per annum. The consumption of England was 34 million tons, with a ratio of 0·66 ton, and the ratio of France was only 0·5 ton per year. The economic, political, and social advantages for France, which resulted from finding a major oil-field in the Sahara need, therefore, hardly be stressed and many large drilling concessions were granted covering the whole of the eastern half of the Sahara and extending into Tunisia and Libya.

These concessions have been taken up by five major oil companies; S.N. REPAL, entire capital held by the French and Algerian Governments; CFP(A), also of entirely French capital; CREPS, 65% French State capital and 35% Royal Dutch-Shell; CPA, with 65% Royal Dutch-Shell capital and 35% French State capital, and finally CEP, a research and exploration company, with a majority share capital belonging to the Government Bureau de Recherches de Pétrole. Numerous other smaller companies have been formed and hold concessions, all governed by the Sahara Oil Code, promulgated in 1958. This code limits the duration of the concessions, distributes in equal shares the profits between the company and the French State, confers on the companies the right to transport their crude oil to the coast or the refinery, and finally leaves the question of customs duties open. A second major strike of natural gas—estimated reserves of 10,000 million cu. m. has been discovered around Hassi R'Mel, about 200 miles north-west of Hassi Messaoud, and a third at Edjeleh, on the Libyan border. At Tiguentourine rich oil-fields have also been found. There can be no doubt that an oil rush has started in the Sahara, the end of which no man can as yet foresee.

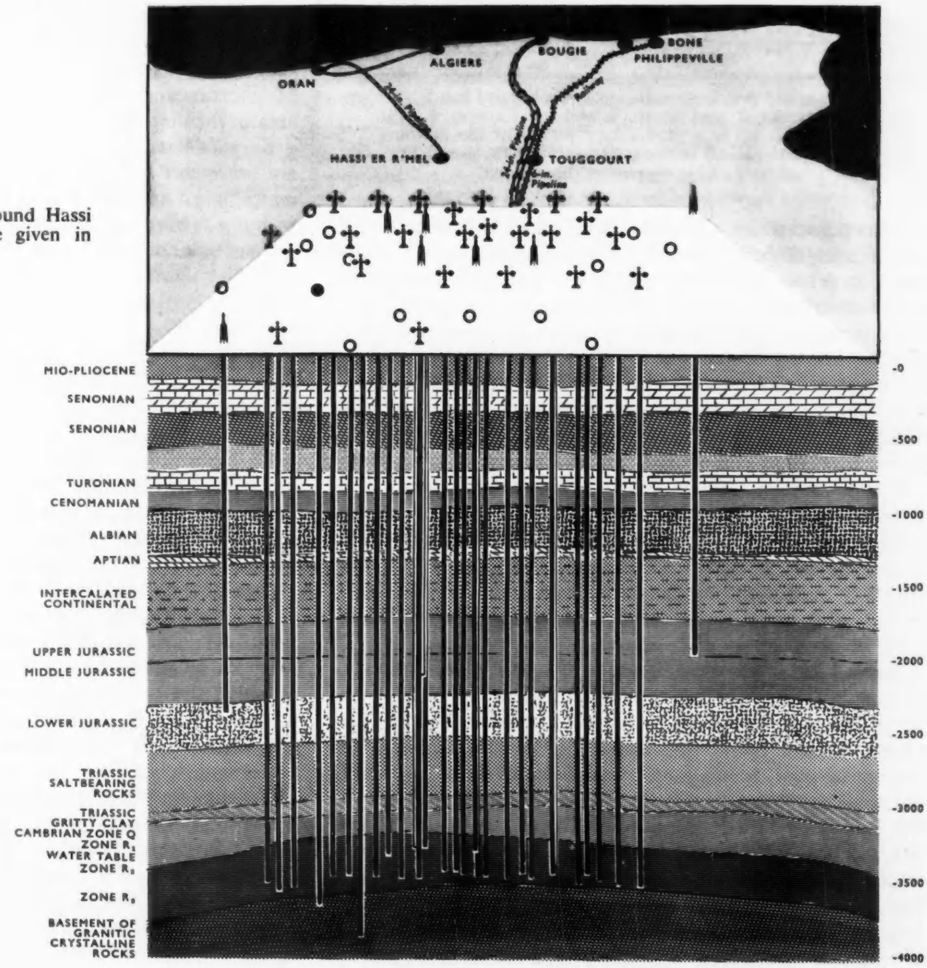
The beginning of the oil story in the Sahara is also shrouded in mystery, and whenever it is discussed the name Conrad Kilian is mentioned; he was one of the first French geologists to realise that oil could be found in the Sahara, but failed to convince either the French Government or the big oil companies of the validity of his theoretical deductions. The real beginning did not come until June 15, 1956, when at a depth of 3330 m. the drill rig of the S.N. REPAL struck oil a few kilometres from the ancient water-hole, Hassi Messaoud. It was crude oil of excellent quality. At a pressure of 480 atmospheres and a temperature of 120°C at the drill end, with a density of 0·803 and without any sulphur, a daily production rate of 800 tons could be envisaged from the very first successful drill; this first well has now been stabilised at around 200 tons per day. Of the subsequent 50 drills which have been carried out, 48 have struck oil in the neighbourhood of Hassi Messaoud and one can therefore understand that the essential auxiliary services were erected with all possible speed. A "baby pipe" of 12 inches was laid to join the oil-field with Touggourt, the nearest rail-head, and on January 1, 1958 the first oil left Africa for Metropolitan France. This small pipe has by now been superseded by the 24-in. pipe and plans are being discussed of duplicating the 24-in. pipe to cope with the future.



One of the characteristic gas torches burning at Hassi Messaoud.

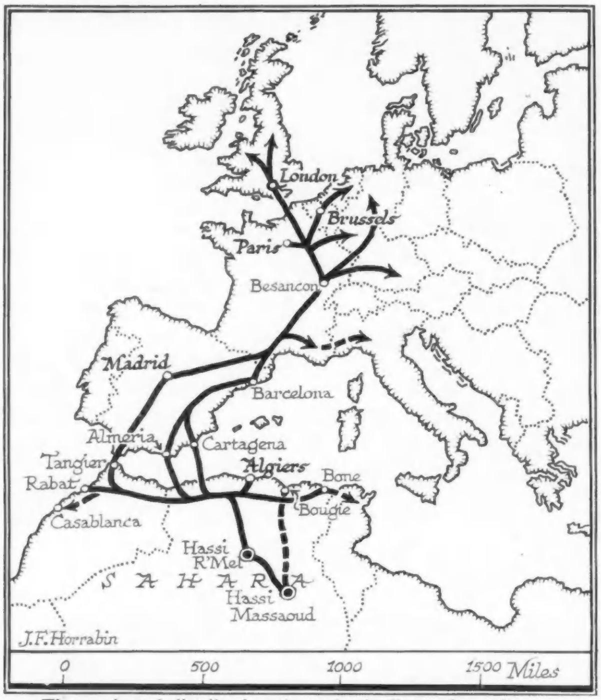
The low specific gravity of the Sahara oil presents a disadvantage for existing refineries, designed to deal with the much heavier oil from the Middle East and Venezuela, but no doubt suitable adjustments in its flow through the refineries should compensate for this. Another unusual characteristic of the Sahara oil is its extremely great content of natural gas, 220 cu. m. of gas per cubic metre of oil. At present there is no outlet for this gas, and the characteristic sight of huge burning gas torches greets the visitor from afar. It is hoped that in the very near future, at least some of this surplus gas will power a 25,000-kW electricity generating station which will supply the camps of the oilfield itself and also the neighbouring oasis of Ouargla.

The laying of the oil pipeline between Hassi Messaoud and Bougie.



1. PROJECTED DRILL
2. DRILLING AT PRESENT (OCTOBER 1959)
3. OIL WELL IN PRODUCTION
4. NON-PRODUCTIVE DRILL

Geology of the oilfield around Hassi Messaoud. The depths are given in metres.



The projected distribution through pipelines of gas from Hassi Messaoud and Hassi R'Mel to Europe. J. Y. Cousteau has made a preliminary survey of the bottom of the Mediterranean in order to determine the possibility of laying a gas pipeline across the sea.
Specially drawn for DISCOVERY by J. F. Horrabin.

The demand for electricity will certainly not be small as the ambitious schemes for creating a city in the desert come to fruition. Already the Maison Verte indicates the shape of things to come. It is a housing estate, entirely air-conditioned, and surrounded by an ever-increasing number of trees; during 1960 alone, it is hoped that 50,000 eucalyptus trees, acacias, cypruses, and other trees will be planted, quite apart from the numerous shrubs and gardens that are already growing in between the houses. All the water for Hassi Messaoud comes from an artesian well, rising from the 1000-m.-deep Albian stratum. At present about 7000 men live at Hassi Messaoud, but as yet no women. All the food they consume, about 50 tons a month, comes by lorry from Algiers, a distance of 400 miles; the trucks are specially built with heat-insulating materials and their own refrigerating units; for the storage of the food, refrigerators of 55 cu. m. capacity are available.

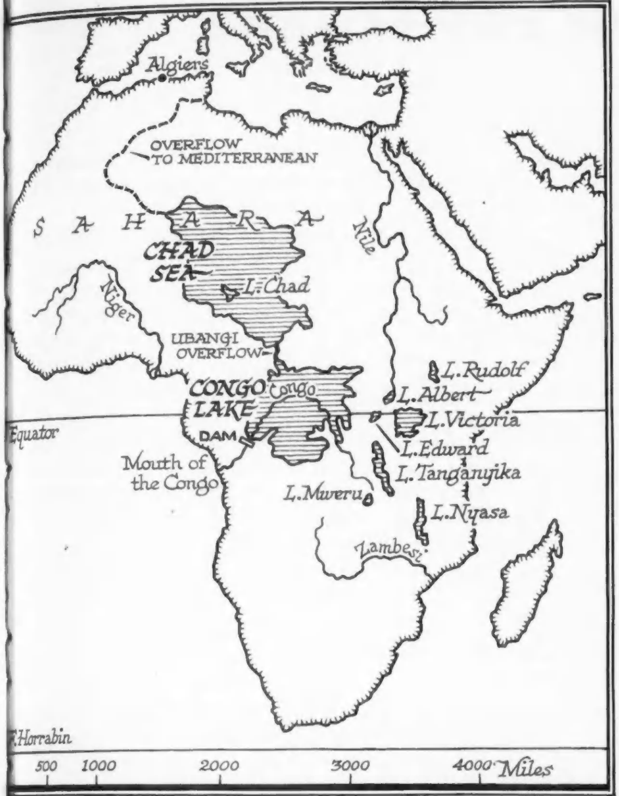
Hassi Messaoud, with its police, fire, and postal stations, with its all air-conditioned living and sleeping space, with its restaurants—serving up to 30,000 meals a month—its shops, lecture halls, its cinema, its inevitable bars, its swimming-pool, tennis courts and football field, is one of the most exciting views in the otherwise limitless desert of the Sahara. It is a living act of faith in the future of the Sahara, brought about by the exploitation of its natural resources. If a sufficiently great number of new towns of this kind could be built in the Sahara, then perhaps the over-population of Algeria could find a rich and healthy life in these new regions, at present so utterly empty of human beings. Indeed, science can guide humanity to a better life, if it is properly applied.

THE FUTURE OF THE SAHARA

Scientific research resembles gambling, the greater the stakes, the greater the possible gains. Unlike gambling, however, the application of the results of scientific research have foreseeable consequences. This can perhaps be best demonstrated in great civil engineering projects such as the Kariba Dam (see DISCOVERY, 1959, vol. 20, p. 428) and the Snowy Mountain project in Australia. In this latter scheme, now well advanced, the flow of whole rivers is reversed and instead of uselessly flowing eastwards into the Pacific ocean, they are now running westwards irrigating vast areas. Furthermore, they produce valuable hydro-electric power. Could not the same be done for the rivers of the Atlas mountains? Instead of running to waste northwards into the Mediterranean, could they not be made to run south into the Sahara? But apart from such an obvious suggestion, far more daring plans have been put forward in the past. Herman Sörgel, a German engineer and architect, suggested in 1935 that a one-mile-wide dam be built in the Chenal region of the Congo river, and thus restore to the centre of Africa the two prehistoric lakes which recent archaeological work has proved to exist in the Ténéré area. However technically feasible his plan may be, it does presuppose a political unity of Africa which seems still to lie in the future. The sometimes discussed suggestions to flood the Sahara with sea water from the Mediterranean, or the Atlantic ocean, is not feasible as the area of the desert is considerably above sea level.

Sörgel's dam and the building of factories in the Sahara are no longer speculative dreams, but engineering projects which merit immediate and careful investigation. Dreams of but a few years ago, like reaching the moon and atomic power, have become reality far sooner than anyone expected. And there must be a large number of other hidden or forgotten projects about the Sahara, like the solar city, for example. This idea of powering a whole town merely by using the energy of the sun, is already out of date since the discovery of oil. But the use of solar energy in selected regions of the spectrum for chemical reactions may be another beginning of entirely new industrial processes. Like hydroponics, such pure scientific research projects, when left to themselves, pay often the richest of dividends. Observations and experiments must be multiplied and must extend over a far wider range if the pressure of population is not going to lead to far greater tragedies in Africa. If the advance of medical science can be blamed for having created the population problem and perhaps its political consequences, then the natural and biological sciences must be brought to bear on an equally large scale to solve the problem of over-population. Only if science advances on a broad front, spreading its benefits over the whole area of human activities, can it guide humanity to a better and richer life.

To sum up then, a systematic search should be made of all the forgotten projects concerning the Sahara, and these should be realistically re-evaluated in the light of present scientific and technological knowledge. What was rightly rejected only a few years ago, may be quite feasible on a pilot-plant scale today, and may tomorrow blossom forth into a new large-scale industry. Basic scientific research into all possible aspects of desert flora and their economic values should be carried out on a really large scale, because



Sörgel's projected dam across the Congo River in order to produce the Congo lake and re-establish the Chad Sea which existed in prehistoric times in the centre of the Sahara.
Specially drawn for DISCOVERY by J. F. Horrabin.

it seems at present, that this will offer one of the most immediate solutions to the question of human habitation. The work of Prof. P. Chouard at his phytotron, where all plants can be grown under carefully controlled conditions, in Gif-sur-Yvette is going to prove no doubt one of the best investments in pure scientific research made by any Government. Bold experiments, based on such theoretical projects and on the results of pure scientific research, must be carried out in a far larger number than they appear at present.

The desert research station at Béni Abbès is but a mere nucleus of the large-scale scientific institute which is needed if the Sahara is to house the millions of human beings who are now growing up in the north of Africa. Closest possible interchange of ideas and scientific results between Béni Abbès and other kindred institutes, whether in Arizona or in Beersheba, either through the existing channels of UNESCO or independently, must become a commonplace and must result in an even more extensive interchange of scientific research workers on an international basis. Such interchange is the natural procedure in many other fields of scientific research, and desert research must follow, if it is to be of any use in the immediate future. If scientific research on a really substantial scale is directed towards the solution of a problem, it is more than likely that even such an age-old problem as the habitation of the Sahara can be solved. Only then will the dilemma be resolved, and "doing good" will have good consequences.

THE ONLY SOLUTION

Finally, science must take up a position with regard to the burning political problem of Algeria and of Africa. The national aspirations of the Africans are, of course, perfectly understandable, just as the legitimate desire of the French population in Algeria is to safeguard their long-standing investments. But let no politician in any underdeveloped country think that terrorism and bloodshed is a cheap substitute for scientific research. Nor for this matter should any colonial administrator imagine that torture and concentration camp form the ideal preparatory school for post-graduate scientific work, nor are they a short cut for irrigation projects or hydro-electric dams. And finally, barricades around a university form rarely the stepping-stones to higher scientific education.

No, the great dilemma which is facing all the new countries in the world cannot be solved by a severance of the ties which link them with the cultural, and hence the scientific, heritage of Western philosophy. The solution to their problems of ever-increasing populations and of rapidly raising their standard of living, can only be achieved by the greatest possible emphasis on scientific research and use of technology. For this, only trained and experienced scientists and engineers can point the way. Unless and until these are available in an equal number in all countries of the world—as no doubt they will be in the future—the quickest solution, and hence the one which will mean the least suffering to the great number of human beings involved in this transition, can only come through peaceful scientific collaboration. The problems which face humanity in bringing the deserts back into cultivation are so formidable that it will require the best brains and the most skilled hands available—irrespective of nationality, creed, or race.

HYDROPONICS IN THE SAHARA

Mme URANIE RENAUD

National Scientific Research Centre, Saharan Research Station, Béni Abbès (Sahara)

In adapting agricultural, and particularly horticultural, production to desert conditions such as those of the Sahara the greatest economy of water is of prime importance, since this is the most severely restricting factor. In any case, water is always a costly item in dry regions.

An ancient and traditional attempt to overcome the extremely difficult Saharan conditions is found in oasis or palm-grove cultivation, where the banks and palms provide a wind-screen, and evaporation is reduced in the partly enclosed area protected by the trees. But the palm-tree itself is responsible for the evaporation of a large amount of the underground water reaching it by its deep roots, and thus reduces the agricultural yield. After any watering of other surfaces, the equivalent of 3 to 5 cm. are wasted owing to the evaporation from the topmost crust of the soil. In addition, the palm-groves, where the soil is usually heavy and insufficiently fertilised, do not, by themselves, always provide the ideal conditions for plant growth which are found in a light, well-fertilised soil.

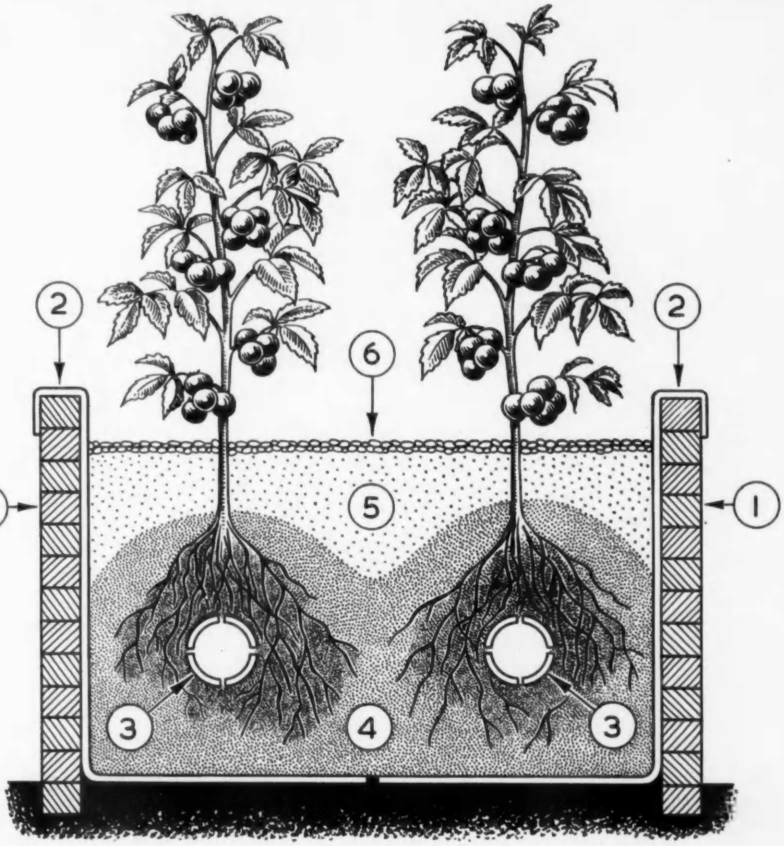
It was for this reason, therefore, that Prof. P. Chouard, on his first visit to Béni Abbès, in 1957, decided to try out different systems aimed at reducing the great wastage of water, which is characteristic of present cultivation methods in Saharan oases, while at the same time using simple materials, such as Samada gravel, crushed pebbles and Erg sand, all of which are plentiful, while true soil is very rare.

Experiments were started in the middle of 1957, and the method which now seems to be the most successful is subterranean irrigation by means of plastic pipes perforated by small horizontal holes. Small amounts of fertilising solution are pumped along the pipes once or twice each day, so that the surface soil is not affected.

FIG. 1. Hydroponic bed at the Sahara Research Station, Béni Abbès. The nutrient solution is contained in the plastic watering-can and through a small electric pump it is injected into the plastic watering-pipes laid under the surface.

FIG. 2. Cross-section through a hydroponic bed.

(1) Outer wall, constructed either from wood, clay bricks, or concrete, depending on availability.
(2) Plastic sheet for inner lining of the container, with a few small drainage outlets in the floor.
(3) Perforated plastic pipes running along the length of the bed through which the nutrient solution is flowing into the soil.
(4) Irrigated zone of the soil.
(5) Silica sand from the desert.
(6) Small pebbles forming a top layer to prevent the underlying sand being blown away by the wind.



Siliceous Erg sand is an ideal cultivation medium, but requires the protection of broken stones to prevent its being blown away by the wind. Hamada gravel at Béni Abbès is too calcareous to be used with success, but the quartz pebbles found in the Ougarta Mountains are admirable when crushed.

The culture is arranged in beds of 4 to 10 m. long by 1 to 1·20 m. wide, with two long, closed-circuit pipes. The solution can be allowed to percolate away, but up to now, with the containers resting on Hamada soil, the best results have been obtained by proofing these with a thin piece of polythene or Rilsal plastic sheet.

The daily variations in temperature in the Sahara allow the cultivation of most plants from temperate or semi-temperate climates, without any ill-effects, even in the middle of summer, and yields range from 12 to 30 kg. of fresh growth per sq. m. every year, with two to five harvests, according to the species grown.

Water economy is considerable: during the winter, when plants such as salads are at the height of their growth and cover the entire surface of the soil, only about 3 litres of water per day are required for each sq. m. In the middle of the Saharan summer about 15 litres are required daily per sq m., that is to say less than half the amount used in the palm-groves for ordinary methods of cultivation, which yield very much less. Apart from the summer months, water consumption can be reduced to 5 to 7 litres daily per sq. m., which is a third of the amount of water generally required elsewhere.

The worst enemy is wind, and protection must be sought by means of walls made of unbaked bricks and dry hedges of palms or reed fences.

Many details still have to be perfected, but research up to now gives the assurance of a great reduction in cost compared with that of importing the same products by air, and in addition, these methods have already shown how great are the possibilities for future development of different cultures, even during the Saharan summer.

In conclusion, the beginning of an era of industrialisation and the arrival of settlers to live and work in the Sahara made it urgently necessary to carry out research into appropriate methods of cultivation. Techniques which aim at water economy and the use of skeleton soil such as sand and gravel are relatively simple and probably the most successful for Saharan conditions, and should result in (*a*) a balanced diet of fruit and vegetables which will reduce the cost and inconvenience of air transport; and (*b*) provide garden flowers for the enjoyment of the settlers.

On May 8, 1957, Prof. P. Chouard of the Department of Plant Physiology, the Sorbonne, described to the Academy of Agriculture in Paris some of these techniques which the author has now tried out on a small scale, with his help and advice.

ECOLOGY IN AFRICA: FROM THE SUDAN TO TRANSVAAL

JOHN PHILLIPS, D.Sc., F.R.S.E.

Professor of Agriculture and Chairman of the Faculty of Agriculture, University College, Ghana

The rich promise of the continent of Africa has caused great haste in the development of her resources. If, however, the appropriate ecological studies were made beforehand, failures would be fewer, and yields would be considerably increased.

Africa, south of the Sahara*, is a concept of convenience to the biologist, the economist, and the administrator. General Smuts used it in discussing political matters and in pleading for a co-ordinated study of the vast and varied land-mass south of the great deserts.

In 1950 Smuts made eloquent appeals to the administering powers to show interest in the intricate pattern of physical, biotic, anthropological, sociological, and economic challenges of the region—and its promises. The first fruit of his appeals was Lord Hailey's "An African Survey" (1938), and some signs of interest by the governments of the sub-continent. After the 1939–45 war all the governments concerned began the studies which are now conducted (as ably as funds and staff permit) by the Scientific Council for Africa South of the Sahara (CSA) and the Commission for Technical Co-operation in Africa South of the Sahara (CCTA).

* For purposes of this note the approximate northern limits of trans-Saharan Africa are set at 18° to 19° N lat.

Since 1948 some of the specialised agencies of the United Nations, such as those concerned with human and animal health, the weather of Africa, and more recently, food and agriculture, have come into action. The World Bank, after special studies in some territories, has given loans for specific purposes. American technical aid and financial assistance are increasing steadily over a wide range of activities. Thus it is evident that the bread cast upon the waters by Smuts in his Rhodes Memorial Lecture at Oxford in 1929 was not wasted. However, he could not have conceived that, within thirty years, administrations constituted by Africans themselves would participate in studies and policies of the kind he had in mind. Within another decade the contributions by African-manned administrative and technical service should be considerably greater, depending upon the degree to which African nationals develop the scientific spirit and approach under the temporary guidance of others.

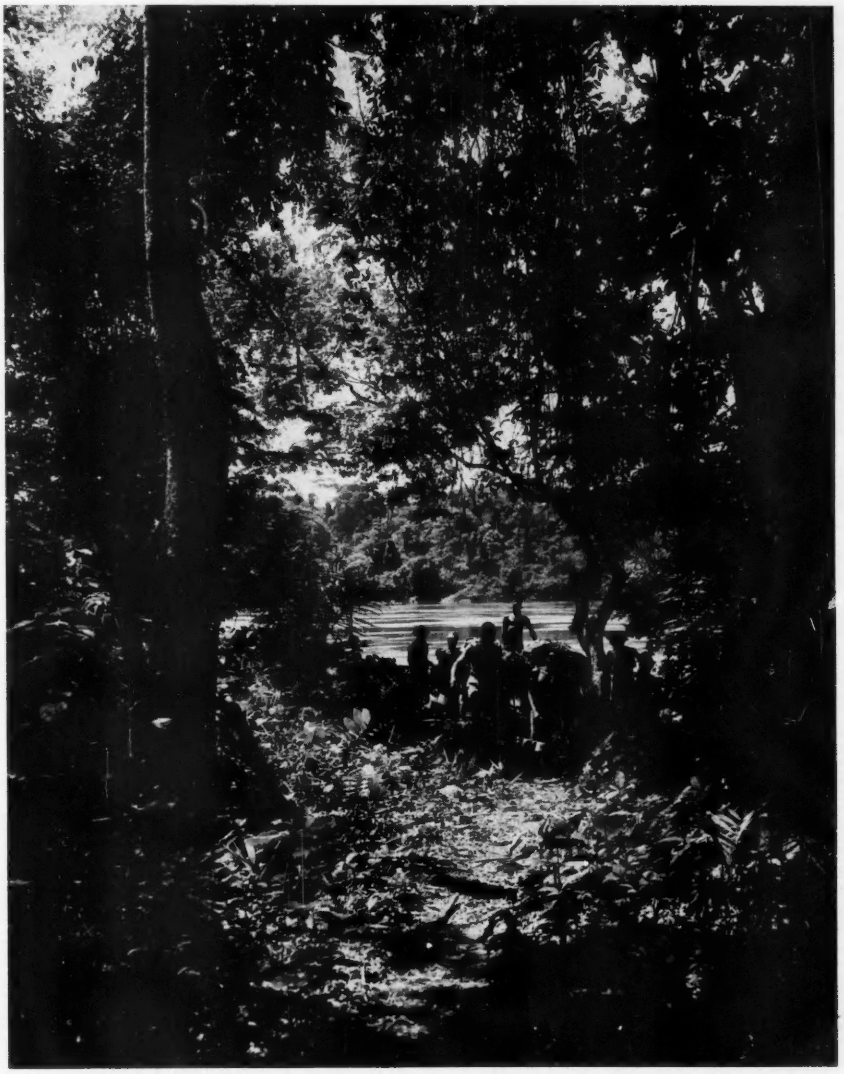


FIG. 1 (*right*). Typical tropical forest in Uele, Belgian Congo. A small native track leading down to one of the rivers can be seen.
(*By courtesy of Belgian Congo Railways*)

FIG. 2 (*left*). Typical African wooded savannah. Elephants of the species *Loxodonta africana cyclotis* photographed near Uele, Belgian Congo.
(*By courtesy of Belgian Congo Railways*)

NEED FOR ECOLOGICAL STUDIES

After the last war the "brave new world" atmosphere provided not only the stimulus for a study of trans-Saharan Africa, but also spurred other nations into providing financial support. It came from Britain, France, Belgium, Portugal, and the United States in evidence of the belief that, given the men, the money, the machines and the moral support, the sub-continent could be made to produce economically a range of agricultural and related commodities. Here was an opportunity to feed, house, clothe, and provide for the general welfare of mankind, for such riches would benefit other nations, as well as Africa.

In 1946 we began to hear much of the attempts at rapid, extensive, and often mechanised development of the resources of various territories. Grandiose livestock ventures and intensive poultry schemes were under way. Projects involving the removal or thinning of much natural vegetation, the rooting, stumping, or levelling of obstacles in Africa's soils; the provision of water in localities where it was either sparse, poorly distributed, or wholly absent; crop production for food, fibre, and oilseed under rain-fed conditions and under irrigation; wattle-bark and fast-growing, exotic timber plantations for mining, pulp, and other purposes; and marine and inland fisheries—these and many other projects were rapidly instituted to yield prodigious returns.

That grand period of imagination, vigour, and enthusiasm is illustrated by the unfortunate East African Groundnuts Scheme, several of the earlier ventures of the Colonial Development Corporation, some of the undertakings by individual governments of various nationalities, and some of the proposals which, fortunately, never materialised from their dream stage in the minds of visiting European and American entrepreneurs. For, although the region is rich in potential, haste is waste in the development of biological resources

The author's own experiences with the East African Groundnuts Scheme taught him much. It also reinforced a

FIG. 3. Typical view of the mangrove swamps near Calabar, Eastern Region of Nigeria. A path had been cleared through the grove in order to lay an electric cable connecting the charges used for the explosions in seismic exploration for oil, carried out in this area by the Shell and B.P. Petroleum Development Co.

(By courtesy of Shell)

previous suspicion: a sound ecological knowledge is essential before money, mind, or action, are committed to the attempt to win harvests and livestock products from relatively little-known sectors of an under-developed country. Evidence gained from visits to other parts of the tropical world as well as to other regions of Africa, made increasingly obvious the dangers inherent in attempts to "tame" a continent *in a hurry*—without giving sufficient forethought to matters such as the fundamental features of local climate, vegetation, soils, water, and local forms and experience in cultivation and pastoral pursuits.

This rash of activity was, in a sense, an inflated projection of the ideas expounded after the First World War: that parts of trans-Saharan Africa were potential sources of dormant wealth capable of supporting millions. Although progress in the last thirty years, especially since 1949, has been marked, it should be emphasised that only the fringe of our ignorance has been touched, for we know very little indeed about the climates, soils, vegetation, animal life, peoples, agriculture, and economy.

For one thing, sources for the necessary information can be nil, negligible, fair, or only locally good. For another, in a rapidly changing continent the range and intricacy of development are formidable. There is, for example, the whole gamut of techniques of crop production and livestock husbandry, and attitudes towards the land.

Ecology (the study of the reciprocal relations of organisms and their environment) is not a science in itself, but rather an approach to the collection of information about the environment, and about organisms and their communities. An ecological approach to the development of Africa would involve protection, management, and expansion of forests; conservation and gainful use of soil and water; "shifting cultivation" and nomadic and transhumance grazing; techniques for controlling pests and diseases; subsistence and cash farming; the practical education of the farming community; the establishment of lines of communication and means of storage of perishable products; the economics of supply and demand; and means for marketing what is produced. It must also include adequate biological, soil, and agro-economic surveys to determine the effect of such changes. For, although the environment

is the stage on which life has its being and plays its part, it is itself inevitably influenced by the actors. In turn, a change in the environment induces an alteration in the community of these actors. The grandiose scheme, executed in great haste, should in short, be replaced—or at least preceded—by appropriate pilot projects of realistic dimensions, checked and supported by agronomics, pasturage, economic, and other kinds of investigation and research. Before beginning any agricultural undertaking, conditions of climate, vegetation, and soil must be considered, together with the ecological setting in terms of the suitability of the area for the objectives in mind. By the time this was thought of for the Groundnuts Scheme it was already too late. But the Volta River Project in Ghana is being preceded by the appropriate ecological study, as was the successful Gezira Scheme in the Sudan.

THE MAIN PROBLEMS

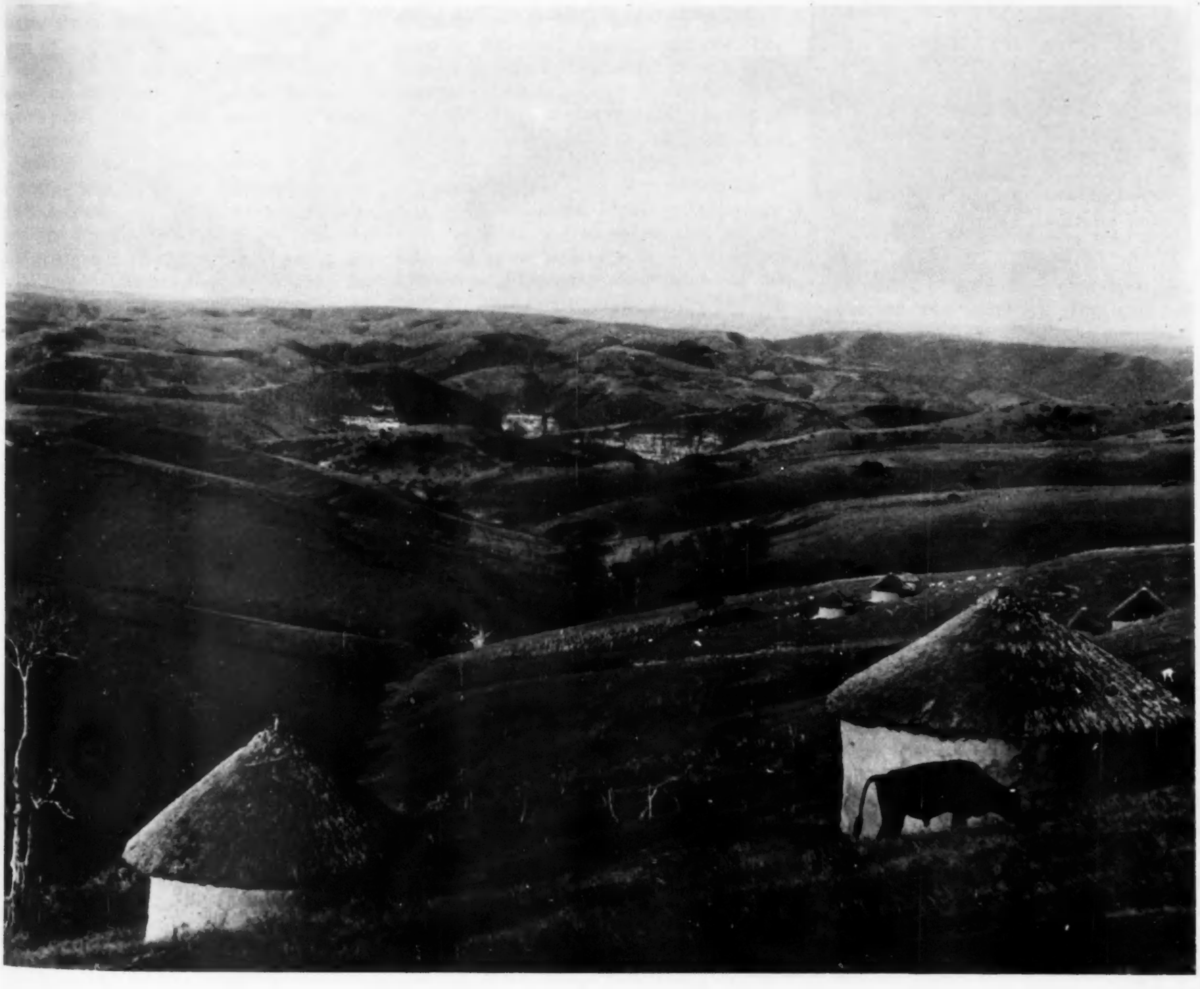
Among the greatest challenges are: **water** in the right place and properly controlled for man and beast as well as for power and industry; **lines of communication**, especially roads and feeder roads for the transportation of produce, and the control of either the **tsetse fly**—the vector of **trypanosomiasis**—or of the disease itself.

This "unholy trinity" of poor water distribution, lack of communication, and trypanosomiasis (sleeping sickness) holds back progress in about three-fifths of tropical equatorial Africa. It may well cost £1000 million over a period of fifty to seventy years to control the tsetse fly alone, and it might prove feasible and cheaper to attack this disease direct.

Although the people of Africa are learning the art and science of development at an increasing rate, the advice, guidance, and executive services of foreign experts will be needed for a long time. Much has to be learned by settlers and Africans alike about agricultural development: its methods, and gainful use of manpower, and business morality.

While physical and biotic hazards are great, it should not be forgotten that Africans themselves must find ways

FIG. 4. Open grassland in the Northern Cape Province, native huts and cattle.
(By courtesy of Satour)



of removing some of the inhibiting influences of their own attitudes towards livestock. Moreover, the communal holding of arable and pastoral land discourages pride of ownership, from which incentive to improve soil and pasturage may spring.

From various indications it is clear that trans-Saharan Africa could produce much greater acreage and much higher yields of subsistence and certain commodity crops, that her livestock could be greatly improved in quality and quantity, and that—in some regions, at least— there could be greater diversification of production. To this end surveys, observations, experimentation, and research are essential. Moreover, basic education and special agricultural demonstration or extension should be given very much greater support. Obviously this involves more funds, and funds are not readily found for some of the poorer regions.

The annual average of recent external loans and grants is about £71 million, and it is too small. Four or five times this figure would be more like what is required. Of course, such a sum would not be utilised gainfully at present. Experienced administrative and technical services of far greater efficiency than those of today are necessary to the wise spending of an appropriate loan.

The elements of an ecological ground plan are required in each and every territory in trans-Saharan Africa because by this means alone will it be possible to treat the problems and the promise of the sub-continent as a whole.

Political advances of great significance have been made and will continue, but unless these are matched by scientific, technical, and economic progress, the sub-continent will not be the more efficient and happier region which her natural potentialities would permit her to become.

READING LIST

Aubréville, A., "Climats, Fôrets et Désertification de l'Afrique Tropical", Paris, 1949.

Hailey, Lord, "An African Survey", Oxford, 1938. Revised edition, 1956.

Phillips, John, "Agriculture and Ecology in Africa: A study of Actual and Potential Development South of the Sahara", London, Faber, 1959.

Smuts, General, The Rt. Hon. J. C., "Africa and Some World Problems" (Rhodes Memorial Lecture), Oxford, 1929.

FIG. 5. A Karroo scene near Meiringspoort Pass, Cape Province.
(By courtesy of Satour)

NEW SCIENTIFIC INSTRUMENTS

ARTHUR GARRATT

Due largely to the Physical Society Exhibition, there are a larger number of instruments than usual to review this month, especially instruments of particular interest to physicists and chemists. Some of the items to be discussed are still in the research or development stage, but it is of obvious value to many readers to know what is just around the corner even if not yet available off the shelf.

In this research category falls the **Storage Potentialities of Thin Magnetic Films.** Such films, which are about 1000 Å thick, can be used as fast bi-stable memory elements for computers. A nickel-iron film evaporated in a uniform magnetic field exhibits uniaxial anisotropy. This can be exploited to provide two stable states which can be switched in tens of millimicroseconds. Not only do such elements promise faster switching than conventional magnetic cores, it seems that they will also be more economical.

Another new development with extremely interesting possibilities is the **Tunnel Diode.** This exhibits a very pronounced negative resistance characteristic and it appears that it will operate in the VHF region. Samples are available for circuit designers to use to gain familiarity with the techniques.

A useful device now available is a **Photoconductive Cell**, housed in a transistor type envelope, which is only about $\frac{1}{2}$ in. long and less than $\frac{1}{4}$ in. diameter. It is designed particularly for industrial switching applications and provides a current of $\frac{1}{2}$ mA when illuminated by a lamp of colour temperature 2700°K at a level of 5 ft.-candles.

A number of well-known electronic instruments are now available in transistorised form. For example, there is an **A.F. Quadrature Oscillator**, battery operated, which covers 0·2 c/s to 20 kc/s in four ranges with an accuracy of $\pm 2\%$ down to 20 c/s and $\pm 3\frac{1}{2}\%$ below that. The two outputs of 0·3 V RMS into 600 ohms are available with a nominal phase difference of 90°.

Still in the prototype stage is a transistorised **Frequency Meter** indicating frequency to an accuracy of $\pm 3\%$. It accepts signals from 1 to 500 V RMS as long as the wave shape exceeds 2·5 μsec. duration and crosses the zero line.

From the United States come details of fully transistorised 10-Mc **Counter Timers.** One of these, a Universal Counter Timer, combines the functions of a counter, time-interval meter, and frequency/period meter. Using conventional circuits, this instrument would need sixty-three valves and consume 350 W instead of the 35 W used by the transistorised version.

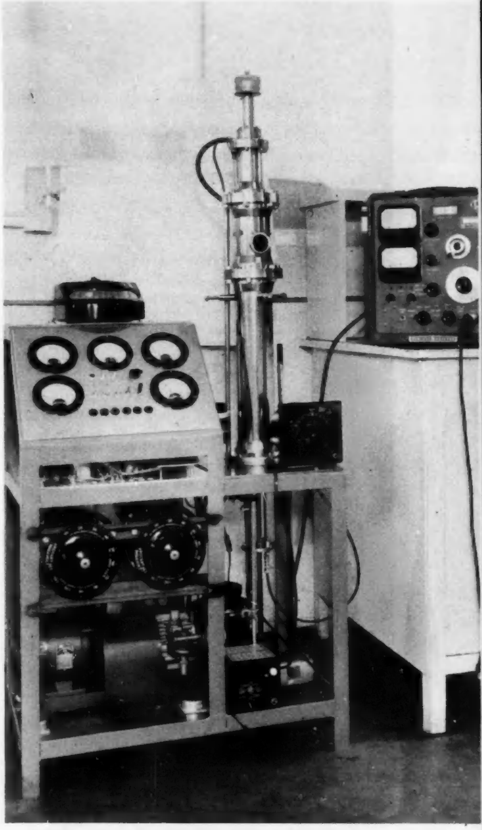
Dielectric Measuring Apparatus is now available for use at both high frequencies and high temperatures. For example, one instrument will measure permittivity and power factor over the frequency range 100–1000 Mc/s at temperatures between 20° and 150°C, and another, still in prototype form, operates up to 1000°C (see illustration).

Salford Royal Hospital has recently installed a new type of **Infra-red Syringe Steriliser** which deals with 360 medium-sized or 600 small syringes an hour. The overall processing time is 28 min., all parameters being pre-set or automatically controlled. It can also be used for drying syringes after washing or sterilising such things as dishes and test-tubes.

The measurement of flow of "difficult" fluids—for example, highly corrosive or with material in suspension, can be carried out to an accuracy of $\pm 1\%$ by an **Ultrasonic Flowmeter** developed for the NRDC. It is particularly suited to the slow flow rates encountered in industrial processes and can be fitted to pipes from $1\frac{1}{2}$ in. to 12 in. diameter. The design is flexible and greater accuracies can be obtained if required. The meter presents both flow rate and integrated flow readings.

A new **Roundness Measuring Machine**, cheap enough for general workshop application and production-line inspection, is now available. Developed in conjunction with the National Engineering Laboratory, it exploits the pneumatic techniques pioneered in this country by NPL and NEL. The pick-up unit rotates at 1 r.p.m. in an air bearing which maintains concentricity to within 5 μin. The pneumatic pick-up magnifies the signals either 5000 or 1000 times and feeds a radial pen-recorder. It will gauge internal diameters from $\frac{1}{8}$ in. to 6 in. diameter and external diameters from $\frac{1}{16}$ to 6 in. diameter.

With increasing interest in soil mechanics, it is gratifying to see nuclear physics being used in this field. A portable battery-operated **Density and Moisture Measuring Instrument** uses gamma rays and a Geiger tube for density measurement and a proportional counter with a source of fast neutrons for moisture determination.



Dielectric measuring apparatus capable of measurements up to 1000°C.

There are several examples of the spread of automatic methods into chemical laboratories. One is a **Rotary Burette** which dispenses desired quantities of liquid with extreme accuracy. Pockets of liquid are compressed by rollers against a shaped track which discharges the liquid with no tendency to add an extra drop or suck back on completion of the dispensation. Quantities from 50 cm.^{3} down to 0·01 cm.^{3} can be dispensed with an accuracy of 1: 400.

Two new **Autotitrators** are announced. One features two independent electronic relay circuits each of which can be set up to operate at any point in the 1 mA input current range. The two independent channels make the instrument extremely flexible; for example, one channel can control fast flow and the other slow or one can add acid reagent and the other alkali to maintain a constant pH value as might be desired in optimum nickel-plating. The other instrument is an inexpensive piece of equipment for process-monitoring. Titration is performed by a simple motor-driven syringe pipette

Acoustic calibrator which uses falling steel balls as a noise source.

coupled to a recorder pen. The liquid is brought to the instrument by a sampling pipeline from the source to be monitored.

A simple **Automatic Pipette** has been designed for routine analysis where large numbers of doses of the same reagent or diluent are required. It consists of a glass syringe with two solenoid-operated diaphragm valves. On switching to "Fill", one valve opens and liquid enters until a weighted piston reaches an adjustable stop. The valve then closes. Switching to "Deliver" opens the other valve and discharges the liquid—the whole cycle taking under ten seconds. Pipettes with maximum volumes of 1, 2, 3, 5, 10, or 20 ml are available.

Ultra-high Vacuum Apparatus is of particular interest to research workers studying surface phenomena, gas discharges, nuclear fission, and ultra-pure thin films. Diffusion pump systems are capable of producing vacua in the ultra-high region, but there must be negligible back-diffusion of gas and non-organic gaskets must be used. Both mercury vapour pumping groups and oil diffusion pumps will produce pressures below 5×10^{-10} torr, and small getter-ion pumps have achieved pressures less than 10^{-10} torr. Pressures down to 10^{-8} torr can be achieved with a Penning ion-pump made of stainless steel. An expendable getter-ion pump, sealed on to the tube being evacuated, will attain a final pressure of 10^{-10} torr. It also functions as an ionisation gauge during and after pumping.

A new type of instrument for measuring pressure, the **Force Balance Unit**, has been announced. It consists of a beam supported by frictionless cross-spring pivots to one end of which is attached an inductive pick-off. The beam is deflected by a pressure capsule and the deflection is zeroed by a precision spring, the tension of which is controlled by a servo motor driven from the amplified signal from the inductive pick-off. It is thus a null device and the pressure in the capsule is indicated by the rotation of the servo-motor shaft. The instrument was designed specifically for aircraft operation and has a range of 0 to 33 in. Hg with an accuracy of $\pm 0{\cdot}05\%$. A miniature version, also capable of fluid measurement, with the same range, has an accuracy of $\pm 2\%$.

From Australia comes an **Ultramicrotome**, which will cut sections less than 140 Å thick. It will take either glass or diamond knives and the advance is by thermal expansion. The cutting speed is variable and it can be either hand- or motor-driven. Lateral movements of the specimen towards the knife have been reduced to a minimum by using a wide steel flexure strip. This makes the section quality less dependent on the perfection of the knife.

It is always pleasing to see how simple principles can be exploited in instruments. An instrument to measure the viscosities of gases and liquids, the **Rolling Ball Viscometer** uses the simplest of techniques; a steel ball which rolls down an inclined steel tube filled with the fluid under test. The time of roll is measured by an electronic chronometer triggered from two contacts. At low roll speeds the viscosity is proportional to the time of roll. The instrument will operate at elevated pressures and temperatures.

Another simple device has been made to check the accuracy of machines used for measuring the breaking tension of textile threads. It is called the **Buckling Spring Calibrator** and it operates on a principle known to everyone who has used a steel ribbon expanding rule stretched without support. Suddenly the rule, which hitherto curved slightly under its own weight, buckles, much to the annoyance of the user. The spring calibrator works in precisely this manner. A curved strip is fixed horizontally and the free end is joined to the moving grip of the machine by a piece of string. The grip traverses as in a normal test until the strip suddenly buckles at a critical value and the tension is recorded on the machine just as though it were testing a thread.

Finally, another basically simple device, an **Acoustic Calibrator** for checking sound-level meters. The noise—a broad band of frequencies centred on 1500 c/s—is produced by a mechanical system of falling balls which fall through a narrow aperture, not unlike a sand-timer, on to a diaphragm and thence into a lower compartment. By turning the instrument upside down, the balls return to their original position ready for the next trial on turning the instrument over once again. The noise produced is 90 db. at 8 cm. and is repeatable to ± 1 db. (see illustration).

MANUFACTURERS

Storage Films. Mullard Ltd, London, W.C.1.
Tunnel Diode. Standard Telephones and Cables Ltd, Footscray, Kent.
Photoconductive Cell. Mullard Ltd, London, W.C.1.
A.F. Quadrature Oscillator. Nash and Thompson Ltd, Tolworth, Surrey.
Frequency Meter. Nash and Thompson Ltd, Tolworth, Surrey.
Counter Timers. Ad Auremia Inc., New York 4, N.Y., U.S.A.
Dielectric Measuring Apparatus. The Plessey Co. Ltd, Ilford, Essex.
Infra-red Syringe Steriliser. Associated Electrical Industries Ltd, Trafford Park, Manchester, 17.
Ultrasonic Flowmeter. British Scientific Instrument Research Association, Chislehurst, Kent.
Roundness Measuring Machine. Optical Measuring Tools Ltd, Maidenhead, Berkshire.
Density and Moisture Measuring Instrument. Dynatron Radio Ltd, Maidenhead, Berkshire.
Rotary Burette. W. G. Pye & Co. Ltd, Cambridge.
Autotitrators. W. G. Pye & Co. Ltd, Cambridge. Baird & Tatlock Ltd, Chadwell Heath, Essex.
Automatic Pipette. Baird & Tatlock Ltd, Chadwell Heath, Essex.
Ultra-high Vacuum Apparatus. Edwards High Vacuum Ltd, Crawley, Sussex. Mullard Ltd, London, W.C.1.
Force Balance Units. Kelvin Hughes Ltd, Knotts Green, London, E.10.
Ultramicrotome. Fairey Aviation Co. of Australasia Pty Ltd, Salisbury, South Australia.
Rolling Ball Viscometer. Coal Tar Research Association, Gomersal, Leeds.
Buckling Spring Calibrator. Wool Industries Research Association, Leeds.
Acoustic Calibrator. Dawe Instruments Ltd, London, W.5.

GEOPHYSICS AND SPACE RESEARCH

By ANGELA CROOME

Experiments in First *Scout* Satellite

The four instruments to be carried in the first joint U.S.-U.K. *Scout* satellite, to be launched during the second half of 1961, were announced on February 2, upon the return of the British national space committee's chairman, Prof. H. S. W. Massey, from consultations with NASA in Washington. The satellite will be launched from the U.S. east coast (Cape Canaveral or Wallops Island) into an orbit of about 55° that will carry it as far north as Edinburgh. The vehicle will be called *International I*, though the joint U.S.-Canadian *Scout* carrying the ionospheric "topside-sounder" experiment is likely to antedate this. The U.S. will be responsible for the satellite shell, the radio arrangements, and temperature control. The experiments to be included in *International I* are as follows:

(1) **Cosmic ray experiment** instrumented by H. Elliot, Imperial College, as described in these Notes in January.

(2) **Electron density experiment** instrumented by J. Sayers, Birmingham University, and described in this month's Notes.

(3) **Langmuir probe experiment** by R. L. F. Boyd, University College, London, to be discussed in next month's issue. This instrument will, in fact, produce three distinct ionospheric measurements —of electron temperature, electron concentration, and the energy spectrum of ionisation in the F-layer region.

(4) **Solar X-ray and ultra-violet** measurements for correlation with the preceding ionospheric studies, also instrumented by R. L. F. Boyd of University College.

It was expected that an announcement about the contents of *Scout II* would have been made at this time. It is understood, however, that a difficulty has arisen since the ozone experiment of the meteorologists requires the satellite to spin and the radio astronomers' experiment needs a stabilised satellite, and a satisfactory solution has not yet been arrived at.

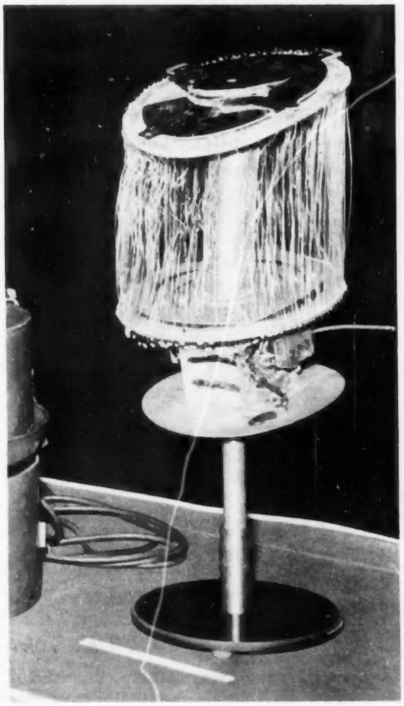
British Space Experiments (continued)

Members of a group at Birmingham University are at work on two pieces of equipment for measuring electron population in the ionosphere. They are extensions of the programme this group has been conducting from the *Skylark* high-altitude rocket at Woomera. Work on these instrument packages has been going on for the past year.

(1) One line of investigation is concerned with measuring the population density of electrons in the ionosphere. This experiment is to be carried in the first *Scout* satellite. Electron population density will be measured by two sensing electrodes projecting out from the vehicle and able to measure the quantity of electrons in the space between them. A high radio-frequency alternating electric field will be applied to the space contained between the electrodes and this will cause an oscillation of the electrons in the field. This oscillation will produce tiny electric currents which in turn will be measured by the sensors. The magnitude of the currents (measured in microamperes) will give the population density of electrons present.

At very great altitudes (where the transition from terrestrial to solar atmosphere takes place) it may be supposed that the gas is completely ionised so that measurement of electron density will yield information on gas particle density which will be useful in understanding the structure of the solar atmosphere and interplanetary gas.

A Birmingham University spectrometer after 100 miles free fall from a *Skylark* rocket, on view in the British Exhibit at the Nice Space Symposium.



(2) The second and more complex experiment seeks to measure with high accuracy the relative numbers of ions of different chemical composition. The method is to use a mass spectrometer of refined design.

By accelerating a stream of ions along a particular flight path, a sorting by mass can be achieved. The acceleration is produced by applying an electrostatic field. The lighter ions will accelerate more than the heavier ones. An electronic shutter in phase with the accelerating device will screen the stream of passing ions in batches. Ten thousand "gate-checks" a second are made by the instrument so that even repeating the count on a particular ion a number of times the entire range of ions can be monitored in a third of a second. The shutter automatically resets at the end of a sequence on a particular ion to that of the next in the scale. The flight time of atomic oxygen (mass 16) is 10 μsec., for instance.

Much of the reduction of the data is carried out within the instrument; the averaging of a sequence of readings for instance is performed before telemetry. Besides assisting the man-power situation, this arrangement also improves accuracy. Due to the limitations in telemetry techniques it has been found that better results are achieved by feeding partly reduced material into the rocket-to-ground channel than in putting in raw data.

The instrument will be ejected from the space-vehicle to some distance on the end of a cable to ensure that it does not register material such as gases emitted by the rocket. In the *Skylark* work the Birmingham group has found no trace of some constituents that have been observed by groups in other countries. The explanation may be that some of the material was derived from the rocket in which the experiment was flown.

Microscope on Mars

Much has been heard latterly of the danger to other environments in space (such as the planets) of introducing organisms

and radioactive elements through the indiscriminate landing of unsterilised space vehicles from Earth. But Dr Joshua Lederberg, the Nobel prize-winning biologist from Stanford University, in his paper on "Exobiology" to the COSPAR Space Symposium at Nice was the first to draw attention to the corollary—the possibility of bringing dangerous epidemics to Earth from the planets through the return of contaminated space-probes. An outbreak of "Martian 'flu" might result, or there might be "disastrous consequences to our agriculture and economy", but it was "far more likely" that a foreign organism would be a "mild nuisance than a dangerous parasite".

Even the Moon may not be as lifeless as supposed. It is a remote possibility that even on the arid surface there exist shaded sites which may contain evidence of the natural interplanetary transport of spore-bearing particles. Beneath the lunar surface there is a chance that the environment may prove reasonably moist with a fairly even temperature and here microbes might survive. The chances of bacteriological life on Mars and Venus are promising.

Dr Lederberg is now building up a team to prepare for exobiological experiments from space-probes. As the primary instrument, an automatic microscope relaying images of its specimens by television is under development. Whatever other life there may be it can be assumed that there will be a prevalence of microbes so that wherever the microscope is landed there will be something to see. Samples would be collected for examination by means of a trailing "fly-paper" of sticky transparent tape which would be drawn slowly past the aperture with its "victims" adhering to it. Refinements of great value would be the incorporation in the instrument of pre-processing baths which would show the presence of nucleic acids or proteins by specific stains; also the treating of lengths of the tape with nutrient solutions so that cultures of the specimens present might develop and be observed directly through the microscope. It is envisaged that the focus would either be pre-set or that a simple servo-mechanism might govern the optics. The development of an automatic microscope would be of great value to biological workers on Earth. It is not yet clear whether television techniques over great distances provide sufficient resolution for this work, but if not they should soon do so. The biggest problem is likely to be the interpretation of unfamiliar images—and it would be dull indeed if the planets have only micro-organisms that are already known on Earth.

No Cliffs on the Moon

The steepest angle on the Moon's surface is only 10°, so that the illustrations of space fiction works showing towering lunar pinnacles and dizzy cliffs are quite fallacious. Prof. Z. Kopal, whose department at Manchester University specialises in the photographing and interpretation of lunar topography reported these new findings at the First COSPAR International Space Symposium at Nice in January.

Work on the series of photographs of the Moon taken at sunrise and sunset over the disc at the Pic du Midi observatory, by Manchester University astronomers, has made clear that in fact the Moon's surface is gently undulating like the Downs. Selenologists have been misled into supposing an abrupt and violent lunar landscape through observing the very long shadows that are apparent. Although the gradients are so gentle, less than an average flight of steps—Manchester workers have found lunar mountains rising as high as the Andes (up to 20,000 ft.).

Prof. Kopal is not optimistic about the chances of the first man to land on the Moon returning alive. He may succumb upon landing even if his vehicle makes a perfect touch-down. The reason for this is that the Moon's sunlit surface must be ionised—in the same way as solar radiation ionises the upper layers of the Earth's atmosphere, the ionosphere. As the Moon has no atmosphere ionisation must occur at ground level. The incoming space-traveller will have a different electric potential from this ionised surface, so that, on contact, he may well be electrocuted. It is not yet clear, however, whether the electrical discharge would be in volts or hundreds of volts, and, therefore, how serious the problem is for systems designers.

Communications on the Moon, it is now becoming clear, will be full of problems. Prof. Kopal named some that are extra to those already well appreciated and discussed in the literature. Radio contact between groups of explorers separated by some distance will be hampered by the greater curvature of the Moon's sphere compared with that of the Earth. The maximum line-of-sight radio-link possible on the Moon is 60 miles. Where mountains stand in the way it would, of course, be much less. On Earth radio-communications can be extended much beyond the line of sight because the ionosphere above the surface reflects radio waves back to the ground. Since the Moon has no ionosphere there is no mechanism by which radio waves can be made to "turn the corner".

Perhaps the best means of passing messages between distant parties on the Moon will be through exploding small charges in the ground that can be picked up by seismograph. Tiny artificial "moonquakes" could be fired to give Morse signals.

The lack of abrupt features on the lunar surface is an advantage for translunar travel and exploration. But the disadvantages due to the lack of an atmosphere more than offset this. Without an atmosphere lubricants will disappear within seconds so that vehicles with moving parts or air-breathing engines will be quite useless. A jet-propelled sledge seems, at the present, the most promising approach to long-distance travel on the Moon.

There was some disappointment at the meeting that although the Russians presented a paper describing in detail the equipment and mode of operation of *Lunik III*'s Moon camera (on the lines already published in the Soviet Press) they had nothing further to add on the interpretation of the pictures and presented no pictures that had not been seen before. General A. Blagonravov, leader of the Russian delegation, suggested a reason for this reticence. Another *Lunik* and more and better pictures of the back of the Moon are expected shortly. This time, he indicated, the photographs would not be taken in full sunlight at full Moon as on the previous occasion. Instead they would be shot when the Moon is in the first or last quarter so that there are revealing shadows from the slanting angle at which the Sun's light strikes the surface.

The 17 countries represented on COSPAR, March, 1960

Australia
Belgium
Canada
Czechoslovakia*
France
German Federal Republic†
India†
Italy*
Japan
Netherlands*
Norway
Poland*
South Africa
Taiwan
United Kingdom
U.S.A.
U.S.S.R.

* Countries not represented at Nice meeting.
† Countries not yet officially confirmed.

Rockets to Sun and perhaps Mars

An American space-probe is to be sent to within two or three radii of the Sun this year. This is announced in the American

space programme for 1960 presented at the COSPAR Space Symposium in Nice in January. A rocket to Mars may also be launched this year by the Russians.

The latter were much more forthcoming about their future plans than they have previously been. Imminent space research plans include the launching into space of capsules containing plants and "also highly organised living beings". This phrase could mean human beings but Russian delegates at the meeting specifically denied that there is any immediate plan to launch a man into space from the Soviet Union.

The Russian earth satellite programme includes the following researches: the study of ultraviolet and x-ray spectra of the Sun and other astronomical objects; mapping the stars using different parts of the spectrum; photography of the solar corona and of various nebulae of the geomagnetic field and its relationship with solar activity; a wide range of ionospheric studies; studies of the Earth's gravitational field, and the establishment of a high precision time service for astronomical purposes. There is also a plan to make a comprehensive study of the action of cosmic radiation on living organisms and of preparing protective measures against these.

The American programme for this year comprises nine earth satellites, one geophysical probe and two space-probes (this includes the Sun-rocket). The geophysical probe will make use of one of the early *Scout* test vehicles launched to travel out to a couple of Earth radii and then return and will make radio propagation measurements. The other space-probe is designed to measure interplanetary plasma and magnetic fields.

Two of the six U.S. earth satellites not listed in the Space Calendar are concerned with the Van Allen radiation belts; two will make ionospheric studies and one each will be devoted to the high energy gamma-radiation arriving from the Sun and galaxy, and to solar spectroscopy.

Underground Explosion Tests

The United Kingdom Atomic Energy Authority is this winter undertaking a series of underground explosion tests to give information on the detectability of small underground nuclear explosions and so provide data for the joint talks in Geneva. Charges of conventional explosives only are used. These explosions may be of value to seismologists also.

Two sites have been chosen for the experiments; they are in contrasted geological formations. Small explosions (of less than 1000 lb.) are to be conducted at a disused mine-shaft of Kit Hill, Cornwall, tin mine. Larger explosions let off at greater depths are possible at the Greenside lead mine, Glenridding, Westmorland.

SPACE CALENDAR

JANUARY (*contd.* See DISCOVERY, 1960, vol. 21, No. 2, p. 80).

Daily firings of small meteorological rockets from each of six North American stations from Alaska to New Mexico. See April.

8–9 Meeting of COSPAR Executive at Nice and new charter adopted. Seven-man Bureau elected under presidency of Prof. H. C. van de Hulst.

9 General A. Blagonravov, head of Soviet delegation to COSPAR, declares U.S.S.R. not likely to send a man to the Moon for ten years, that is until able to return to Earth as well.

9–29 Visit by British Space Scientists to NASA, Washington, to finalise arrangements for *Scout*. Members: Prof. H. S. W. Massey, Dr H. Elliot, Dr A. R. Wilmore.

11–16 COSPAR first space symposium at Nice. See reports separately.

11 Russians announce tests of 12,000-mile super-rocket towards Hawaii in Pacific between January 15 and February 15. Shipping to keep clear.

18 Self-inflating 100-ft. sphere launched by two-stage rocket to 250 miles high off Virginia and used to bounce radio signals from New Jersey to Massachusetts.

19 £A160,000 placed in contracts for extending Woomera rocket range.

20 First launching of new Russian rocket into Pacific (successful). Stated distance travelled: 7770 miles.

20 Designer of *Black Knight* motor, David Andrews, circulates report stating that four 1-ton satellites could be launched in 1965 by *Blue Streak* combination at a total cost of development of £21 million. Described Advisory Council on Scientific Policy's estimates as "extravagant guesswork."

21 Announcement that U.S. *Project Midas*, early warning satellites, to be launched in six months' time. Programme covers six satellites to fly at 1500 miles high and equipped with infra-red sensors able to detect missiles within one minute of launch.

28 U.S. satellite to signal by means of flashing light announced. To be placed in pole-to-pole orbit and used for geodetic measurements.

29 Pres. Eisenhower to ask for additional $113 million for development of *Saturn* rocket.

29 Additional $113 million provided for *Saturn* development.

29 First of two of largest emulsion stacks ever made flown for eight hours 22 miles high over Caribbean by U.S. Navy and Chicago University.

31 Second and last test of Russian super-rocket over Pacific completed. Shipping ban in area lifted fifteen days early. Tests have proved rocket capable of 27,000 m.p.h. and so able to reach Mars or Venus.

FUTURE SPACE CALENDAR

SPRING

Tiros I, U.S. satellite experiment with specially designed infra-red television scanner for monitoring cloud-cover due.

Echo, 100-ft. inflatable satellite for proving passive communications, due to be launched by U.S.

FEBRUARY

6 French *Veronique* rockets scheduled for launching from Colomb-Béchar (Sahara) carrying sodium and potassium ejection experiments.

MARCH

Sputnik III and *Lunik III* due down.

APRIL

Daily firings of small meteorological rockets by U.S., as in January.

JUNE

4 *Veronique* rockets to be fired, carrying sodium (2) and "chemical explosion" (2) experiments.

JULY

Daily U.S. meteorological rocket firings as for January and April.

AUGUST ONWARDS

Long Tom, Australian developed sounding rocket to be launched to test projected Australian experiments for U.S. *Scout* satellite.

AUGUST

15–20 11th International Astronautical Congress of IAF to be held at The Royal Institute of Technology, Stockholm, Sweden.

SEPTEMBER

16–22 International Rocket Week to take place under COSPAR auspices.

OCTOBER

Daily U.S. meteorological rocket firings as for January, April and July.

DECEMBER

10 *Veronique* rockets to be fired carrying Lyman-alpha experiment and another to measure the diffuse light in the sky.

The Southern Cold Temperate Zone

The sparse land-masses of the southern hemisphere, South America, South Africa, Antarctica, Australia, most resemble exclamation marks punctuating the ocean—with the dot (Australia) that completes the South African mark swept off to one side. The pattern of land amidst the waters is predominantly "up and down". But the pattern of distribution of the land's flora and fauna in the same hemisphere is very markedly one of circular stripes. A similar pattern of zonal distribution appears to divide up the creatures of the sea. The boundaries of the zones lie pretty well along the fortieth and fiftieth parallels, the sector between these latitudes being known as the "southern cold temperate zone". It has a characteristic climate.

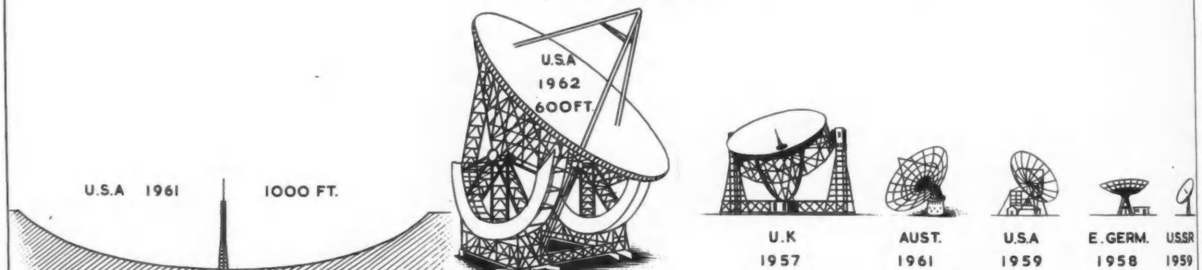
The broad character of biological populations in the southern hemisphere's lands and seas was amply documented at a two-day meeting on the southern cold temperate zone held by the Royal Society early in December as part of the Darwin centenary commemoration. The explanation of this biological distribution remains a baffling puzzle. In contrast to the northern hemisphere, a very much greater part of the southern hemisphere is covered by the oceans. The migration of species, plants as well as animals, is hard to understand. Yet the types of creatures and vegetation to be found, for instance, in Tasmania, has more in common with the fauna and flora of Tierra del Fuego (off the tip of South America) than with southern Australia, which is barely 200 miles from Tasmania, and to which it was connected as recently at the Late Pleistocene period.

The elucidation of such biological population problems is of more than academic interest. It has an immediacy that the leader of the Royal Society meeting, Prof. C. F. A. Pantin of Cambridge, was at pains to stress. The crucial scientific problem now facing Man was not how to achieve the maximum rate of technological progress but how to predict the future of life on our planet. Without such predictions we shall not be able to take the necessary steps to prepare for or adapt to changing conditions. But prediction rests on adequate reading of past biological history, and much of this has yet to be unravelled.

Major biological changes are now being brought about in the space of a single human generation. Man has sought to control Nature—and his efforts are putting Nature out of control quicker than has ever been recorded before. Soil erosion follows the plough; the widespread use of insecticides—many of which kill much else besides insect pests—is having an incalculable effect on the biological balance. An understanding of one major sphere of biological relationships will help with the elucidation of all the others—and speed up the chance of predicting our biological future before it is upon us catastrophically.

PERSPECTIVE OF THE WORLD'S LARGE RADIO TELESCOPES

(drawn to scale)



	U.S.A. 1000 ft. (1961)	*U.S.A. 600 ft. (1962)*	*U.K. 250 ft. (1957)*	*Aust. 210 ft. (1961)*	*U.S.A. 142 ft. (1959)*	*E. Germ. 120 ft. (1958)*	*U.S.S.R. 72 ft. (1959)*
Site and institution	Puerto Rico (Cornell University)	Sugar Grove, W. Virginia (Naval Research Laboratory)	Jodrell Bank, Cheshire (Manchester University)	Parkes, near Sydney (CSIRO)	Hillhead, Fraserburgh, Aberdeen (Stanford Research Institute)	Adlersdorf, E. Berlin (Heinrich Hertz Institute)	Outside Moscow (Lebedev Physics Institute)
To be used as radar?	Yes	Yes	Yes	Yes	Yes	No	Yes
Surface	Solid	Mesh (adjustable)	Solid	Mesh (adjustable)	Mesh	½ Mesh, ½ Solid	Solid
Minimum useful wavelength?	3 cm.	28 cm.	21 cm.	10 cm.	800 Mc/s	21 cm.	3 cm.
Focal length	600 ft.	240 ft.	62½ ft.	95 ft.	60 ft.	30 ft.	31 ft.
Principal research	Radar studies of planets	50% defence, 50% radio-astronomy, especially of solar system	Planetary and galactic studies; space-probe tracking	Discrete sources	Defence. Radar echoes from *aurora*	Solar studies	Planetary studies
Cost	?£100,000	$79,000,000	£750,000	£A750,000	$250,000	?	?

LETTERS TO THE EDITOR

Exercitationes duae Anatomicae de Circulatione Sanguinis

Sir:

In his June 1959 review in DISCOVERY of my translation of William Harvey's 1649 publication ("Exercitationes duae anatomicae de circulatione sanguinis", Cambridge, Roger David. Rotterdam, Arnold Leers), my colleague, Dr L. Chauvois, while praising my rendering, expressed regret that I had not brought out the point of difference, in his opinion essential, between the "Exercitationes duae . . ." of 1649 and the "Exercitatio anatomica de motu cordis et sanguinis in animalibus" (Francofurti, sumptibus Guilielmi Fitzeri) of 1628. I regret my inadvertent error of omission, and fully agree that my annotation should have begun with a reference to Harvey's pre-auricular venous sources of the circulating blood, though his concept of a fermentation of the blood within these was disproved by Lower (Lower, R., 1669, "Tractatus de corde item de motu et colore sanguinis et chyli in eum transitu", London. John Redmayne for James Allestry) and others, to whose writings and experiments I had referred in my *Physiol. Rev.* (1928, vol. 8, pp. 346–64), and in my book, "A Monograph on Veins" (1937, Springfield, Ill., Charles C. Thomas). At that time I had particularly in mind the work of Allison (1839, *Amer. J. Med. Sci.*, vol. 23, pp. 306–23), while Senac, a century earlier, had written that "On n'observe point que le sang bouillonne en sortant du coeur, il n'occupe plus d'espace que le sang artériel; dans les artéres mêmes il n'est pas plus rarefié que dans les veines." The same writer (p. 230) said that the heart's activity is innate, but that the skeletal muscles support its activity by their tonic movement acting upon the veins, an idea which was re-expressed by Yandell Henderson *et al.* in 1934 (Henderson, Y., Oughterson, A. W., Greenberg, L. A., and Searle, C. P., 1934, *Science*, vol. 79, pp. 508–10) in their note about "the third major mechanical factor in the circulation of the blood".

The contraction of the veins which enter into the auricles was Allison's main subject of interest and research, and a century later, in 1938, Champy and Louvel wrote of "La contraction de la veine cave supérieure" (*Paris Medical*), and also filmed the rapid systolo-diastolic contractions of the terminal portion of this vessel which occurred in an experimental animal. I have myself seen it sufficiently often in such subjects, but cannot off-hand recall having seen it in the cineradiographic records of unoperated ones, though I should not be surprised so to do. Dr Chauvois in 1951 wrote a small work ("Place aux veines. Rôle initial et primordial du secteur veineux dans le circuit sanguin", Paris, Amédée Legrand et Cie) entitled "Place aux veines", in which he indicated the "rôle initial et primordial du secteur veineux dans le circuit sanguin"; he also referred to a review of "Veines", by J. Louvel and J. J. Laubry, in "Les petits précis", Paris, 1950, but I am myself happier with the literature I have already mentioned, for it is better—in my view—documented in respect of its subject.

K. J. FRANKLIN

Sciencemanship

Sir:

It would be indecent of me not to write to you to say that I enjoyed tremendously Dr D. Michie's brilliant Review of Dwight Ingle's recent cogitations on Research and Researchers (DISCOVERY, June 1959, vol. 20, No. 6, p. 259). Sit tight and don't worry, we shall soon have:

(1) International Assoc. for Prevention of Cruelty to Scientists, with national, local, and laboratory branches;

(2) Institutes for study of *how* to research, apply it, and jam it;

(3) Weekly national meetings to exchange ideas on these matters, emphasising non-coital cross fertilisation;

(4) Monthly inter-nation congresses for the same;

(5) Journals in 81 languages, including Aztec, Aramaic, and Assyrian to serve as a medium for

(6) An international translating to serve item (5);

(7) An inter-nation travel bureau (run on scientific principles by scientists for scientists) to serve (4);

(8) A national closed-circuit big brothers' TV circuit to implement item (3);

(9) A vast engineering and construction organisation, preferably organised by retired generals and admirals, for implementing item (2);

(10) A truly dedicated, well-meaning idiot to organise item (1).

M. C. SHELESNYAK

Weizmann Institute, Israel.

Films Build Tradition in Arabic World

Sir:

I should be grateful if you would correct an error which occurred in my article on film in Kuwait (DISCOVERY, May 1959, vol. 20, No. 5, p. 223). I quoted the number of deaths from heat exhaustion and heat stroke in the Persian Gulf as being 200. It should be in fact 20 for the whole of the Persian Gulf.

L. GOULD-MARKS

Errata

The Outer Planets

In the article published in January 1960, page 27, figure 3, the drawing of Uranus by Dr W. H. Steavenson should be rotated anti-clockwise through 90°. Figure 2 of the same article was published by courtesy of the Mount Wilson and Palomar Observatories, whereas figure 4 was published by the courtesy of the Lowell Observatory.

New Directory

World Directory of Atomic Research Reactors

Detailed information on seventy-seven research test and experimental reactors in twenty-two countries is given in the second volume of IAEA's Directory of Reactors which was published in December 1959.

All the reactors which have been described are either currently in operation or under construction. A third volume covering remaining research reactors will be issued in the middle of 1960.

The reactors have been grouped in six main categories: Light water moderated, pool type (20 reactors); light water moderated, tank type (10 reactors); liquid homogeneous (19 reactors); solid homogeneous (9 reactors); heavy water moderated (13 reactors); graphite moderated (5 reactors); organic moderated (1 reactor).

Full details are given for one representative reactor in each group and for those reactors having little similarity with any other. For the remaining reactors in each group general information and major modifications are presented. The detailed information includes physics data and data on the core and the fuel element, core heat transfer, control, reactor vessel, overall dimensions, reflector and shielding, containment and cost estimate. Sketches are provided of the fuel element assembly and of horizontal and vertical sections of the reactor.

The reactors described are situated in the following countries: United States 37, United Kingdom 7, France 5, Germany 4, Canada 3, Belgium, Denmark, Italy and Sweden 2 each, and one each in Australia, Austria, Belgian Congo, Brazil, Greece, Iran, Israel, Korea, Norway, Portugal, Puerto Rico, Spain, and Venezuela.

THE BOOKSHELF

The Hand of Life: The Story of the Weizmann Institute

By Ritchie Calder (*London, Weidenfeld & Nicolson, 1959, 78 pp., 30s. net*)

The Weizmann Institute in Israel has been described as one of the most effective research complexes in the world. This account, for the general reader, is published to mark the twenty-fifth anniversary of the Daniel Sieff Research Institute, the original laboratory at Rehovoth. This laboratory was for chemical research, but since 1949 there has grown up round it, in what was then a barren wilderness, a fine, and still expanding, institute, capable of undertaking research in most of the principal fields of modern science—from biology to nuclear physics, from biophysics to applied mathematics. The nine departments have a staff of 180 scientists and some 400 assistants. There are good research facilities for visiting scientists from abroad, and the institute is a truly international centre. The funds that made all this possible were subscribed to mark the seventieth birthday, in 1944, of Chaim Weizmann, that remarkable—indeed unique—combination of scientist and statesman.

These are, however, only the bare facts of a story whose interest is at least as much human as technical. The founding of the Institute was a great act of faith, for when the decision to expand was taken, the future of Palestine was uncertain and the plan was carried out during years of extreme national anxiety, when the very survival of the new state was a question. The Weizmann Institute is not only a memorial to a great man: it is also a memorial to the tenacity and enthusiasm of the young Israeli nation. It is an exciting story, which Mr Ritchie Calder tells in characteristic style.

T. I. WILLIAMS

An Atlas of Africa

By J. F. Horrabin (*London, Victor Gollancz Ltd, 126 pp., 12s. 6d.*)

"They owned the land almost as a man now owns his hat; they bought it and sold it, and cut it up like cheese or ham; they were free to ruin it, or leave it waste, or erect upon it horrible and devastating eyesores." Thus H. G. Wells ("In the Days of the Comet") deplored the 19th-century system of land ownership in England "that made such an extraordinary tangle of our administration of the land upon which we lived". The opening words also serve well to illustrate Mr Horrabin's views on the matter of the foreign ownership of Africa.

Mr Horrabin has been a prolific cartographer of contemporary history ever since he began drawing historical maps for H. G. Wells forty years ago. It is a pleasure to see the present small volume added to his other atlases of current events. "An Atlas of Africa" is a series of maps showing the changes in the distribution of African land among foreign powers from 1870 to the present, and is an invaluable guide for the layman seeking to find his way through the great shuffle. Opposite each map is a full-page caption consisting of a brief historical summary and the author's strong liberal opinions.

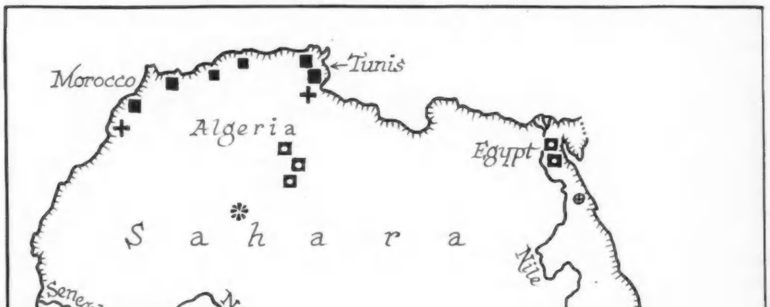
Here one can trace the history of a single country from its existence as a kingdom or city-state, to colonisation by successive foreign powers, and (in some cases) through to independence. Here too, one will find a concise summary of Africa's technological, agricultural, and medical problems in maps which show the natural resources, population, railways, air routes, water power, and extent of scientific activity.

The author argues that since "the great scramble", as he calls it, for bits and pieces of Africa, European powers have contracted an overwhelming debt to that continent. Africa has given Europe diamonds, gold, uranium and other minerals, and oil, in addition to the profits from the slave trade. In order to pay this debt, many more settlers are needed—but settlers of a very different kind: scientists, technical experts, and skilled workmen who will help Africa to develop her natural resources; men who are willing to offer assistance to equals—not directions to inferiors.

The maps are simply drawn; the text is concise and straightforward. It is no discredit to Mr Horrabin to say that it is a book which every school child should own.

V. SCOTT

The distribution of raw materials in Africa.
(Reproduced from "An Atlas of Africa" by courtesy of the author and the publishers.)



Insect Life in the Tropics

By T. W. Kirkpatrick (*London, Longmans, Green, 1957, xiv+311 pp., 146 text figures, 35s.*)

This book, according to its jacket, provides a description of the insect life of the humid tropics "primarily addressed to those interested in natural history who want to know something of the teeming insect life which is such a striking feature . . . of tropical countries". It is further claimed that "Entomologists trained in a temperate country should also find it a useful introduction. . . ."

To deal successfully with so large a field in so limited a space implies a considerable condensation with possibilities of a congested style and the omission of important subjects. However, the book is well produced, the approach is logical, the style easy, the illustrations excellent and well chosen, the subject-matter comprehensive, and the claims made completely justified.

The introductory chapters are on The Tropical Environment, The General Structure of Insects, and Classification. Then follow chapters on Development, Reproduction, Locomotion, Food and Feeding Habits, Defence and Protection, Insect Architecture and Insect Communities. An index is provided. Each chapter is a careful and readable account of its subject, and examples are well chosen from among the less publicised species. As an illustration of the careful and logical arrangement of the book, the chapter on Locomotion is divided into Walking and Running, Speed of Walking, Jumping, Swimming (with a diversion on why not many insects swim in the sea), Flight, Speed of Flight, Range of Flight, and Phoresy. Each section is a complete and authoritative précis in itself and with the index makes the book easy to use for specific points while still retaining an easy flow when read continuously.

The book is so attractive as to whet the appetite for a more extensive account from the same pen. R. BASSINDALE

Yearbook of International Organisations

(*7th edition, 1958–9, published by the Union of International Associations, and available in the United Kingdom from the UIA representative, E. S. Tew, Esq., 91 Lyndhurst Gardens, Finchley, London, N.3, 1269 pp., 78s.*)

This volume is published with the "official collaboration" of the United Nations. It begins with a foreword by Dr Wallace Atwood, Jr, who is a member of the Executive Council of the UIA as well as Director of the Office of International Relations of the American National Academy of Sciences. Dr Atwood takes the IGY as his example of the efforts of international exchange and co-operation and emphasises the need for a directory of the plethora of international organisations which now exist. Moreover, as Dr G. P. Speeckaert, the Secretary-General of UIA remarks in his Introduction, this volume shows how international organisations are growing and flourishing.

The layout of the *Yearbook* is well designed. There are six sections, the first of which gives much information about the United Nations itself, its specialised agencies and non-governmental bodies having a working relationship with it. Section Two is entitled "The European Community" and is concerned with Euratom, the Economic and Coal and Steel "Communities". Section Three deals with "other inter-governmental organisations"; where we find bodies like the Administrative Centre of Social Security for Rhine Boatmen and the Balkan Alliance, the Commonwealth Agricultural Bureaux, and the Western European Union.

The largest part of the volume is taken up by Section Four, "International Non-Governmental Organisations". This section is divided into eighteen sub-sections, each of which lists the appropriate organisations for particular fields. It is interesting to observe that the largest "area" is that made up of agricultural, technological and scientific organisations, although the largest single "area" is devoted to commercial and industrial bodies. Section Five deals with "National Organisations in Consultative Status with the UN" (for example, bodies like the Anti-Slavery Society for the Protection of Human Rights) and with the Institutes of International Affairs. The final section contains indexes of various kinds, including a very useful thirty-six pages which are, in effect, a glossary of initials and what they mean—in these days of "names" like AETFAT, AGHTM, and even those which are more pronounceable like FIG, it is very useful to have such a list.

The entries themselves are informative and well laid out, giving the title of the organisation in English, German, French, and Italian, the address and telephone number, the date of the organisation's foundation, its aims, member countries, structure, officers, finance, general status, activities and publications—all, in fact, one could require.

The *Yearbook* is well printed and cased. It will undoubtedly be of great use to all scientific, university, and other departments or organisations dealing with matters on an international level. Moreover, if added reason for acquiring the volume be needed, there is always the excuse that it may be good to "browse" through its pages, especially as the volume lists organisations with titles like the International Association of Seed Crushers!

C. A. RONAN

What They Read and Why: No. 4 in the series Problems of Progress in Industry

By Nigel Calder (*H.M.S.O., 24 pp., 2s.*)

Bernard Shaw once said, "Reading rots the mind". Surprising facts have now been unearthed which suggest that Britain's scientific and technological research workers may be in secret sympathy with this Shavian dictum.

A little while ago the Department of Scientific and Industrial Research asked the Social Survey Division of the Central Office of Information to conduct an inquiry into the reading habits of applied scientists and technologists. The findings are summarised in Nigel Calder's pamphlet. The survey covered more than 1000 industrial scientists, technologists, and other senior technical staff in the electrical and electronics industries. In so dynamically expanding a field one might think that the case for *improving* the mind by reading the scientific literature was unusually strong, and the risks of rotting it correspondingly small. However, the DSIR and COI felt that the first step towards coming to conclusions should be (in the words of Nigel Calder), "to put aside any preconceptions of what technologists *ought* to make of the literature, to step into their shoes and see what importance they really attach to it".

In "What They Read and Why" the first surprise is as follows: "Do technologists read to find something out? No." The question was put, "If you want information on a technical problem which you cannot solve from your memory or your usual standard references, what do you usually do first?" Only one in five replied that they would go to the library or some other source of literature. The rest said that they would ask somebody else (usually somebody working in the same organisation), either by picking up a telephone or walking down a corridor. The majority could not remember any occasion on which they had obtained useful knowledge from a scientific or trade journal.

The investigators thought that perhaps they were asking the question in the wrong form. So they tried to tie their victims down by asking those who were currently engaged on a problem, "What steps did you take today/yesterday?" *Only 2% of those that did anything about their problem in the twenty-four hours before the interview had referred to the literature.*

Why, then, do scientists and technologists read at all? The survey's answer is "for ideas and stimulation". Perhaps this throws light on the startling finding that 59% of those questioned did most of their technical reading at home. Calder points out that "children, television, domestic chores, and so on, must often be distracting to say the least". Presumably, therefore,

the scientist and technologist picks up a journal in much the same spirit as he picks up a newspaper or detective novel —looking for topical news and relaxation, and certainly not regarding it as a natural part of his job. It comes, perhaps as an additional shock for those who take the non-Shavian view, that the average technologist only sees about five journals regularly.

Does all this matter? For the non-Shavian who has managed to retain his preconceptions in the face of the facts so far cited, it presumably matters very much. His interpretation would, I suppose, be that the nation's scientists and technologists are misguided or lazy, that they do not know what is good for them, and that they *ought* to read far more journals in a far more serious, sober spirit. Calder himself favours the conclusion that wide reading of the literature helps to make a good technologist. On the other hand, this is his one conclusion which is not buttressed by objective and unambiguous fact. It is true that the survey found that men with higher degrees see about twice as many journals as do the remainder. But this is in itself not good evidence, and may merely introduce a spurious correlation between merit at the job and the amount of reading. For various reasons, men with higher degrees are likely to be better technologists than others, and for various other reasons they are likely to do more reading. About the most striking feature of the report is the total lack of factual evidence that scientific and technological workers get anything more out of reading the literature than plain fun.

This being the case, I am tempted to offer a suggestion. Why should not scientists, technologists, and scientific editors draw the moral when it comes to writing and publishing articles and papers? If the reader reads for fun, why not write in such a way as to give him as much fun as possible? This means that anything that can be said with a picture instead of with words should be deported from the text into a picture. By the same token, printed numbers, whenever possible, should be converted into histograms, curves, isotypes, and so forth. After all, why does television threaten the magazine circulations?

Language and style should be colloquial, short of irritating the small but possibly important *literary* section of the readership to the point where they actually stop reading. A striking feature of colloquial speech is that it is pictorial, rightly so, because most people think in pictures. This means, among other things, that passive constructions, so loved by scientific writers, should be shelved and replaced by the frank use of "I" and "We". The reader can visualise a person and likes to feel that there is *someone* there talking to him. One of the reasons for the immense readability of Darwin, and many other early scientific writers, is the honest and disarming admission of personal existence, and, by implication, of all the personal weaknesses, passions, and predilections which make up a man, as distinct from the discreet paragon which modern scientific opinion would have us pretend to be.

This means that much pride and prejudice will have to be jettisoned. I would even suggest, however outrageous it may sound, that the scientist and technologist must be prepared on occasion to seek the guidance of advertising experts when it comes to presenting his work on paper: for these are the people whose craft it is to use words and pictures to put information across in ways which can be readily understood and remembered. The fact that the advertiser's information is so often false or even pernicious is no argument against the utility of the same techniques when it comes to communicating genuine and valuable information.

Returning to the DSIR pamphlet, "What They Read and Why", a strong impression emerges from it that the overwhelming mass of scientific information is circulated and exchanged through talking—talking in pubs, talking in clubs, talking at departmental coffee, talking at home with scientific friends amid the clutter of "children, television, and domestic chores". If the DSIR maintains the objective and systematic approach which is so pleasantly and so readably exemplified in this pamphlet, we may, I hope, soon expect a follow-up entitled "What They Talk About and Where".

D. MICHIE

New Opportunities for Deaf Children

By I. R. and A. W. G. Ewing (*University of London Press Ltd., 15s.*)

There has been considerable progress in the understanding of educational treatment of the deaf child since "Opportunity and the Deaf Child" was written in 1945. The time is now ripe for a new book from the Ewings' pen. This present book is designed to help the parents of deaf children to integrate their child into normal family and social life. The opening chapters deal with the importance of hearing, and by comparing a hearing twin with a deaf twin, demonstrates the difficulties of a deaf child, and points ways of guidance. These are useful chapters which could well be expanded. The sections dealing with testing of hearing loss, although necessarily condensed, will probably still be too long for the average parent. Many parents will have gained sufficient knowledge of examination technique at their own child's interview. These chapters are of more value to those whose work is connected with the care of deaf children. The section on hearing-aids will be found useful by both parents and others interested in the deaf. A new impetus to deaf education has been given this year by the Ministry issue of transistor aids to children. This section provides some of the fundamental knowledge necessary in order to gain the maximum benefit from the aid. It also includes information on group aids which will be of particular interest to teachers. Home training is rightly stressed as of utmost importance. A chapter is devoted to amplify the advice which parents should have received at early interview, and the chapter dealing with preparation for school is written with understanding of the problem. It is a sad reflection that it is still necessary for many young children to leave home to gain an education. This chapter provides help for those families whose lot it is to be separated. Almost one-third of the book is devoted to case histories. The experiences of the eight children make very interesting reading and are written frankly. Probably the number of histories could, with profit, be reduced. The closing chapter gives a useful survey of existing educational systems which are open to deaf children.

This is a book written by acknowledged experts on the care of the deaf. It is written in an interesting style but one which is not always easy to follow. The sentences of 80 to 100 words need to be read and re-read in order to be understood. It would be a help for parents if the scientific jargon could be explained. What is a sonogram or a phoneme? It might be useful to know the difference between "severe", "very severe", "profound", or "subtotal" when applied to deafness.

This book, written by authorities of world-wide repute will be welcomed by those who are seeking a simple yet comprehensive account of the present-day position of deaf children and some of their problems.

Z. P. GRAY

Investment in Innovation

By C. F. Carter and B. R. Williams (*London, Oxford University Press, 1958, 167 pp., 15s.*)

In this book, published on behalf of the Science and Industry Committee, the authors analyse factors affecting industrialists' plans for investment in new plant equipment. The study is based on material gathered in the preparation of their previous book, "Industry and Technical Progress". The authors aim to distinguish between the opportunities for investment and the reaction of business men to those opportunities. They argue that innovation creates opportunities for investment and is to be seen as a factor in its own right, playing an integral part in the system.

SCIENCE ON THE SCREEN

TELEVISION

Science on American Television

The American television scene is so different from our own that it is somewhat difficult for a European to understand its complexities.

The first great difference is geographical. The United States is more like a continent than a country. It is made up of large sparsely peopled tracts of country separating small areas with high population density in different time-zones as one moves from coast to coast. So large is the U.S.A. that several thousand separate television stations operate simultaneously. The differences of time have encouraged the use of filmed programmes which can be staggered in time in the different zones. Now, however, video-tape-recording is being used extensively with improvement of picture quality and economy of operation.

The second point of difference is that all United States television is commercial, there being neither listener licensing nor Government sponsorship. Nearly all programmes are organised and paid for by advertisers and the majority of stations are tied to one of the three major networks.

Commercial television means a large bias towards audience-pulling programmes such as musicals, Westerns, and "soap-opera", consequently science gets very little air-time on the networks. There are notable exceptions; for example, the Columbia Broadcasting System has been running a series called "Conquest", introduced by Eric Sevareid, which is a straight, excellently conceived and produced science programme. But, in the contemporary scene in America, there seems little chance of science becoming mass entertainment—a necessary condition if it is to get peak-hour screening on the networks.

The outlook is rather different in the field of education. The shortage of teachers in the United States has encouraged educationalists to use television for direct teaching and for the provision of refresher courses outside school hours for the teachers themselves. This is in distinct contrast to the use of television for educational purposes in Britain where the BBC, Associated-Rediffusion and, lately, Granada, transmit regular schools' programmes designed to enrich existing schools' courses and not to take the place of a live teacher.

An educational programme of particular interest is the "Sunrise Semester" series presented by Harvey E. White, in colour, at 6.30 a.m. every morning on the National Broadcasting Company's network. There is no direct advertising on this programme but it has considerable commercial support and its credit caption reads like a page from *Fortune*! Such a programme makes no concessions to the television medium and is really a straight lecture using a blackboard and without any specially prepared visual material—it might somewhat irreverently be called "chalk and talk"!

In complete contrast to the advertising stations, there is a growing number of ETV (Educational Television) stations operated as a public service by universities and other educational groups. Many of these are financed by a membership system with interested viewers paying a small annual contribution and receiving regular mailed programme schedules. ETV stations, which are usually non-profit-making, operate on very small budgets. The station staff is often largely composed of students or trainees who "go commercial" as soon as they are proficient. Hence, the technical quality of the programmes is very low even if the enthusiasm of the operators is high; 256 channels have been set aside by the Federal Communications Commission to be used solely for educational purposes.

A typical ETV station is KQED in San Francisco—the QED is deliberate! It is operated by a non-profit community corporation, the Bay Area Educational Television Association, with a governing board of twenty-three directors. Its subscription rate is $10 per annum—or more if desired—and subscribers receive a monthly programme schedule "KQED in Focus". The station started operating in 1954 on a shoestring—"short on cash and long on ingenuity" as the Association claims. It now has 6000 members and a budget for 1958–9 of over $340,000. About 30% of this comes from subscriptions, the rest is raised largely by special gifts and production contracts for programmes sold to the National Educational Television Network. KQED transmits adult educational programmes, Monday to Friday from 4 p.m. until 11 p.m.—a total of 35 hours a week; 8% of this time is devoted to science. In addition, 16 programmes for schools are transmitted weekly for an audience of 120,000 in 45 contracting school districts. Two of these programmes are Fifth Grade science lessons.

Attempts are being made to increase the service areas of ETV stations. Interesting experiments are at present under way using high-flying aircraft fitted with repeater equipment to increase the effective horizons to 100 miles.

The general picture that emerges from the United States shows that science programmes for the masses have not arrived and there is no evidence that they are just around the corner. On the other hand, the selective viewer who lives in a city area has a choice of several regular scientific programmes, usually completely educational. Such programmes are more akin to classroom lectures than to the efficient and well-conceived science programmes provided by British television, albeit too rarely. ARTHUR GARRATT

January Television

The rare adult science programmes which ever appear on ITV are certainly exasperating from the viewpoint of rationally organised television viewing. Month after month passes without any real adult broadcasting on science on the commercial channel, a record which has long been condemned in this column. Then, without the slightest hint or pre-warning, either in the official printed programme, the *TV Times*, or verbally by a pre-announcement, distinguished scientists are interviewed and their views broadcast. Two such interviews have appeared during January in what are called "Magazine" programmes, which in fact are not even given the credit of a mention in the condensed "Viewing Guide" in the *TV Times*, the guide which contains what that paper thinks are the really important items.

Since no one in his senses can be expected to sit glued to ITV television the whole of every evening, night after night, it is quite evident that one can only strike such a science interview by mere accident, if there has been no warning of its impending appearance. This seems to be an extraordinarily ridiculous weak piece of administration, especially from an organisation that repeatedly boasts its sense of publicity and, indeed, whose very life's blood is based on its expertise claims in publicity. For the two interviews under comment certainly deserved a great audience.

In the one, Prof. J. D. Bernal appeared on "This Week", where he was interviewed on the problem of world food shortage. He made the telling point that

a 25% increase in world production would suffice to meet all requirements. It is perhaps not sufficiently realised that the margin between sufficiency and hunger is very small indeed. A slight amount less than you need at each meal, and the result soon becomes serious. Prof. Bernal's main thesis was that the formidable undertaking of a 25% increase could never be solved by private action and was essentially a matter for governments, and he strongly urged the governments in the more fortunate States to take drastic steps to assist the governments of the needy States. He made out a very strong case for helping the underdeveloped areas.

The second, equally unheralded programme, curiously enough, also involved a physicist. In it Prof. P. M. S. Blackett submitted to a twenty-minute critical interview carried out by W. Clark, the economist. Prof. Blackett cogently pointed out that the great majority of trained scientists are engaged on technological and production problems and only a small fraction devote their activities to pure research. He predicted that we might well look forward to big improvements in preventive medicine and in food production. The underdeveloped countries, he argued, don't need new science, they need trained manpower and great amounts of capital to apply already existing knowledge. Clearly, the problems are educational and political rather than scientific. He, too, independently came to the same conclusion as Prof. Bernal: the problem was so great that only State administration could grapple with it.

He agreed, paradoxically, that science could indeed lead to an actual increase in poverty if preventive medicine leads to an increase in population, yet if at the same time food and material production lag behind. Hence, he argued, equally, if not more important than preventive medicine, must go vast developments in material production, especially food. In his view the primary political issue of the future was the extreme need to reduce the gap between the "haves" and the "have-nots" by the extensive application of science and technology.

Now when two such formidable scientific administrators and protagonists like Profs Bernal and Blackett can be induced to appear before the cameras and submit to critical question and answer on matters of scientific administration of such great moment, it seems quite incredible that absolutely no advance mention or indication should be given. Their theme is a matter which commands universal interest. No doubt the "Magazine" organiser will retort that his programme is essentially a live up-to-the-minute broadcast so that of course there is no time to get the content into print. But this is no argument at all, for neither of the interviews can be classed as "hot" news. Both scientists have long made their positions clear in their publications, and there cannot be the slightest excuse for the absence of a pre-announcement in print. As to failure to pre-mention verbally, this has not even the lamest excuse.

Are we back again to what your reviewer has long suspected and occasionally argued? Does it not, in fact, look very suspiciously as if ITV is just not interested at all in science as such. Its past history certainly seems to point that way. True it is that ITV regularly broadcasts some admirable schools science, which we have usually rated highly here, but naturally enough it just simply must include science if it is broadcasting to schools at all. When it comes to adult science broadcasting, then ITV leaves us between the devil and the deep. Either it does not broadcast science at all, or if it does, then we are not informed in advance and it springs science interviews on us out of the blue.

This is just not good enough for a national service. S. TOLANSKY

FILMSTRIPS

Upon Thine Own Head

Filmstrip Tells Story of Scientific Research into the Cure for Dandruff.

35 mm. colour cartoon, filmstrip with commentary on disc. Produced for Bayer Products Ltd by Unicorn Visual Aids Ltd; 49 frames; sound recorded at 33⅓ rpm. (*Available on free loan from The Social Statistics Department, Bayer Products Ltd, Neville House, Eden Street, Kingston-on-Thames, Surrey.*)

This is frankly, and quite openly, an advertising filmstrip to show hairdressers a new ethical product for the treatment of dandruff. Nevertheless it is of interest to anyone who is concerned with this problem. The producers suggest it might be of interest to senior forms of girls' schools, science associations, women's groups, etc. Your reviewer found it interesting, instructive, and rather startling.

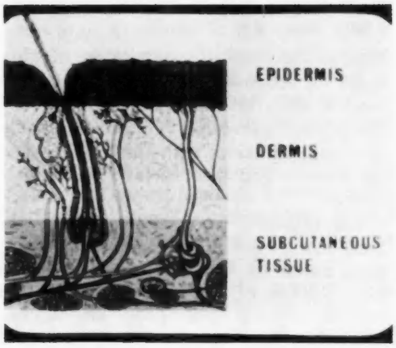
It treats the subject in a simple, scientific manner. Dandruff is a fungus related to over-activity of the sebaceous glands of the scalp largely due to hormonal unbalance. The recommended product contains selenium sulphide and lorothidol.

The strip gives rather astounding statistics of the increase of dandruff, particularly among the professional classes. An independent survey has shown that there are about 10 million cases in this country. The majority are among young adults. One person in four would appear to be affected to some degree and 2% admit that the case is serious.

If, as your reviewer believes, this is largely a scientific treatment of the subject, then the advertising which is purely in the credit title and the last frames, is not obtrusive. It may do something to stop the black-magic methods which were commonplace among barbers in the bad old days. Any attempt to instruct those who work on the fringes of science, like barbers, should be watched with interest.

As a visual aid it is mixed in quality. The statistical and unscientific frames are too much like an advertisement; though some of the diagrams are very attractive they are not very clear. They do not suggest a serious scientific treatment of a semi-medical subject. However, when there is something definite to show, the micro-photographs or scientific diagrams are direct and to the point.

The whole presentation would be more convincing and more coherent if it were more uniform and simple in visual treatment. It is always irritating if there is a



Shots from the Bayer Products Ltd, filmstrip on dandruff and its treatment with selenium sulphide (Lenium).

(*Above*) Cross-section of normal scalp.

(*Below*) Cross-section showing the overgrowth of the upper layers of the epidermis which results in the common "scurf".

lack of punctilious uniformity in a presentation. It is most important to stimulate and to hold the interest of a group. Nevertheless it is a confession of failure if the filmstrip maker has to use mere gimmicks to hold an audience. There can be a steady stream of design, without pandering to the supposed inability of a specialised audience to pay attention for thirteen minutes—the length of the strip.

It is a step in the right direction that manufacturers regard their customers as sufficiently adult to give them the scientific background which caused a new product to be pioneered. It is a pity that they have not realised that a completely factual presentation would be more effective scientifically and would also stimulate sales. L. GOULD-MARKS

The History of Radio

Produced by Mullard Ltd, with the cooperation of the National Committee for Visual Aids in Education. General Editor, K. E. J. Bowden, B.SC. 35 frames colour, with teachers' notes. (*Distributed and made by Unicorn Head Visual Aids Ltd, 42 Westminster Palace Gardens, Victoria, S.W.1. Price £1*)

Here is the first of a new series of filmstrips for secondary modern schools. The second strip in the series will be *The History of Television*. Mullards intend to continue this series with further strips on the history and basic principles of electronics.

The teachers' notes are well laid out. They are bound at the top like a shorthand notebook. When opened they read from the top of one page straight to the bottom of the next. They are written clearly and on the whole simply. It is a pity that the titles in the notes are not synchronised with the time when the picture should be changed. In certain cases, if the teacher follows the frame numbers he will have finished talking about the image before he projects it on to the screen. All the same, when a teacher knows the strip it will be simple for him to mark the notes and make the changes at the right moment.

The strip starts with a transmitting-aerial as a symbol of man's endeavour to establish communication with his fellows all over the world. It goes on to smoke-signals. A fire covered with damp brushwood transmits the message. The column of smoke is interrupted to carry a message in code. From this point the student is led straight into early electric telegraph instruments. This strip goes on to show simply but clearly the development of telephony up to the most modern frequency modulation and television broadcasting.

I was worried when I saw the first four frames, but they proved to be in a different style from the rest of the strip, which was just as well, for they are neither so clear nor so satisfactory as the later pictures. This is largely because the style of visualisation distracts from the subject-matter. Rather crude drawings of Land-Rovers, covered wagons, and so on, dominate the screen, leaving the important objects like the aerial and the smoke-signal in the background.

As so often happens with scientific visual aids, when we come to the representation of circuits and equipment the pictures are very clear. Some of them are fairly complex and would need to be held on the screen long enough to be studied carefully. I cannot help feeling that a little more thought could have produced a uniform colour code throughout and the elimination of some unimportant details. Image simplification is one of the essentials of any visual aid.

In one of the early frames, for example, various points in the diagram are lettered from A through to I. Each letter indicates a component which should be looked at and understood. I do not think that this, and a number of other pictures, would be clear if the teacher did not use a pointer. Probably "a luminous arrow-torch" would be best. It could be used easily, as most of the coloured diagrams are against a dark background.

The arrangement of the subject is logical and complete. From a teaching point of view it should be extremely useful. Some of the frames, such as those on the relation between electricity and magnetism, are models of visual clarity.

On the other hand, there are some frames making an analogy between switching on an electric current and a train starting off, the circuit being at the top of the frame and little trains at the bottom. The effect of this is rather confusing, like so many comparisons. They are excellent for starting one thinking but dangerous if carried too far. The impact of these images could be slightly distracting and possibly even confusing.

The treatment of waves, on the other hand, is both lucid and simple. The development of the electronic valve, beginning with the Fleming diode, could have been better. The illustrations leave over half the screen blank, and they might have been improved if they had used a diagrammatic treatment rather than a realistic one. But this is a matter of opinion.

Nevertheless, this strip shows how valuable, and indeed almost indispensable, well-conceived filmstrips are to the teaching of science. In their small boxes enough filmstrips to illustrate a complete course can be kept in a single drawer. It would take a teacher quite a long time to produce a single one of these drawings on the blackboard. To produce the lot would be a major task.

The faults, as well as the merits, of this filmstrip show that visual-aid production is no easy task. Careful thought, meticulous planning, and first-class production techniques are necessary to produce a teaching-tool which is completely effective. In spite of any criticism, this filmstrip will probably be used for a number of years to come.

It is greatly to Mullard's credit that they have realised that public relations should begin at school. If industry can be persuaded to aid education, it will certainly profit in the long run by a higher standard of employees and informed customers. L. GOULD-MARKS

Inside the Living Cell

By Marie Neurath. 28 frames colour with teachers' notes. (*Copyright by the Isotype Institute. Produced by Common Ground (1951) Ltd, distributed by the Educational Supply Association Ltd, 181 High Holborn, London, W.C.1. Price complete, £1 7s. 6d.*)

This strip explains what happens in living cells. It describes growth, heredity, virus and gene, and genes and heredity.

The notes are clear, concise, and to the point. They explain each image in terms as simple as the subject permits, and they should be convenient for the teacher to use under projection conditions. This seems to me a great advance on some of the other Common Ground teachers' notes.

The final note was particularly stimulating, as it suggests an integrated use of visual media. It says: "It might be advisable to develop some of the diagrams on the blackboard, especially those in the section 'Heredity', and discuss them at greater length. In that case it should be agreed which symbol and colour stands for father, mother, father's father, etc."

It is always advisable for the teacher to expand "packet" visual aids to meet the needs of his students, but only too often the producers of visual aids like to give the impression that a strip, or a film, is sufficient unto itself. This is a dangerous assumption. I have only one additional remark on the notes, and it is one that I have made before and will make again: filmstrip producers must indicate somewhere in the notes precisely the intellectual and age group at which they are aiming. It can be very frustrating not to know. I agree that the title itself is indicative, but not sufficiently so.

The visual presentation is good, as is all the work of the Isotype Institute. I particularly like the combination of

photomicrography with coloured stylised drawings. On the whole, the level of illustration is uniform, but one or two drawings could have done with more thought, if the meaning of the picture is to be immediately understood by the audience.

The demonstration of Mendel's Law is particularly clear, and in general the section on heredity is an outstanding example of the value of static projection in teaching. Only the flannel board could do the job as well. Film would move too fast, and it would take too long to draw the necessary diagrams on a blackboard.

It is interesting to note how a technique like Isotype, which is eminently successful in demonstrating statistical data, can also be used effectively in putting over scientific information. It seems to show that the art of using visual, symbolic language in communication is universal. If one learns to think in terms of expressing concepts visually instead of verbally, one develops an almost barristerial ability to analyse a brief, and then to translate it into terms of image, colour, and composition.

When we come to the section on "genes and heredity" the images become almost Egyptian in their stylisation, and I fear that they are distracting in their very visual attractiveness. This shows the complexity of the problem of the use of symbolic visual signals in communication. The message conveyed may not be the logical one intended. It may well produce an entirely different impact. In fact, as the subject is complex it may offer an escape route for the less-interested pupil. The "variety of structure", for example, might well suggest, "Wouldn't that make lovely wallpaper?"

It is, however, a most satisfactory and useful attempt to put over a complex subject simply and clearly. The fact that the producers recommend the use of additional visual material on the blackboard shows that they are aware of the limitations, and advantages, of a 28-frame filmstrip. Without hesitation, your reviewer recommends teachers to look at the filmstrip, which they should certainly find most useful.

L. GOULD-MARKS

FILM

Photo-emission

16 mm. Sound. Black and white. Running time, 18 minutes. (*Produced by Merton Park Studios for Mullard Limited in conjunction with the Educational Foundation for Visual Aids; made in co-operation with the National Committee for Visual Aids in Education. Produced in 1959. Directed by David Cons. Scientific advisers, Mullard Research Laboratories; educational adviser, L. S. Powell, B.Sc., A.Inst.P. Distributed by EFVA, 33 Queen Anne Street, London, W.1*)

This is the eleventh of the EFVA Advanced Science Series. It is designed, as were the other films, for science specialists in grammar-school sixth forms, and for students at a similar level in technical colleges, and perhaps universities.

These films have a dynamic purpose, which they largely fulfil. They are a practical part of the drive for better and more up-to-date scientific teaching. In many cases these films not only teach the student but bring the teacher new knowledge. As the experiments shown, and the demonstrations, use expensive equipment, not usually available, in a number of cases the teacher sees the experiment for the first time in the film.

While your reviewer was seeing the film—which is fresh from the cutting-room—EFVA received a request for the film from Chile. This shows that these films have an international reputation because they fulfil a universal demand.

Photo-emission once again has received financial support from industry. Six of the advanced science series have been sponsored by Mullard Limited. We can only hope that this will be an incentive for other industries to follow this lead.

The film opens by showing the construction of a modern photo-electric cell, unfortunately the first shot of this is not very clear. It is always difficult to photograph glass valves. It would have been a good idea to use diagram at this stage to avoid confusion and to make a transition between the real object and the stylised animated diagrams which are used so successfully in the film.

A laboratory experiment is demonstrated in which a photo-electric cell is exposed to a monochromatic light-source of variable intensity. This is measured, and the first law of photo-emission is deduced. "The number of electrons emitted is directly proportional to the intensity of the incident light." Wisely, the law is shown on a sub-title so that the students have a pause in which to consider the finding. It is also very valuable with science students, who may have trained verbal minds, to give them an opportunity to read as well as hear the commentary and see the demonstrations.

The next demonstration shows how the energy of the electrons is affected by the intensity of the light-source. This leads to the second law of photo-emission: "The maximum energy of emitted electrons bears a linear relationship to the frequency of the incident light."

The explanation for these phenomena cannot be given by the classic wave theory of light. Well conceived animated diagrams introduce the quantum theory of Planck and Einstein.

The film summarises its message by showing various ways in which photo-emission is put to work practically. For example, it is used in the control of the correct registering of colour printing, in the photo multiplier, and in the image converter, which changes radiations we cannot see into visible light. This is used to intensify the image gained by using very small x-ray intensity. A similar tube is used in the shutter of a high-speed camera which gives exposures of the order of three millimicroseconds.

The almost diagrammatic film treatment of the laboratory sequences is very interesting. It just shows the demonstrator and the equipment against a grey background. This stark efficiency is somewhat marred in the first sequence as there is an unexplained piece of equipment on the left-hand side of the screen. The diagram work, which was supervised by Charles Legge of Larkins Studio, is as efficient and clear as the similar diagrams he supervised for the British Electrical Development Association's series of educational films. The only symbol which was at all questionable is the one used for the quantum of light-energy, or photon. This is a short-wave symbol and the visual impact is somehow not clear, but this is unlikely to affect the serious science student.

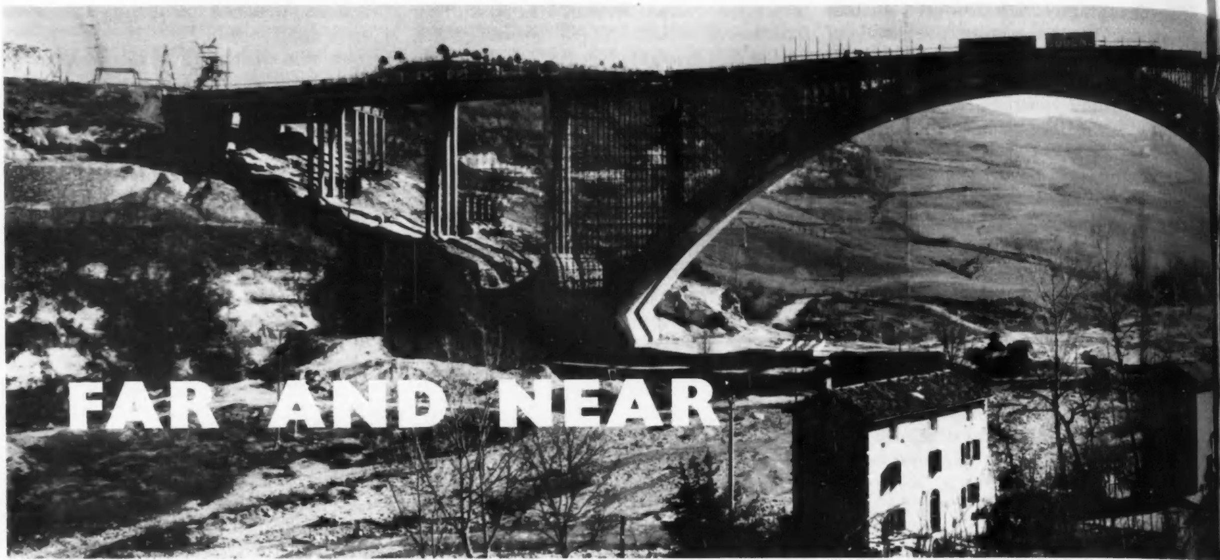
The use of graphs in conjunction with the animated diagrams of a photo-electric cell is effective. If it had not been done so carefully and skilfully it could have been muddled and confusing.

When dealing with the positive forces set up by the ions on the surface of the cathode, the diagrams become somewhat less effective than they were earlier in the film, because they represent these forces by interrupted lines vertically cutting across the circles which represent atoms. These lines are distorted to indicate that they are trying to hold electrons in the cathode. At this stage it is the commentary which holds the exposition together. This is not a serious fault; it is rather an indication of how extremely difficult it is to represent advanced science clearly by symbols.

This is a good film and should put over a very difficult subject as clearly and as simply as the audience-level demands. The teacher's notes are good and clear, with twelve pages of additional information for teachers, besides a summary of content and a printed commentary. The notes are illustrated by diagrams and graphs, and there is a bibliography of references. It is only to be hoped that the Advanced Science Series of EFVA continues to expand and flourish.

L. GOULD-MARKS

FAR AND NEAR



(*Above*) the twin-arch viaduct bridge which crosses the Sambro River, near Bologna, North Italy. Its total length is 380 yds., and maximum height of the arch is 480 ft.

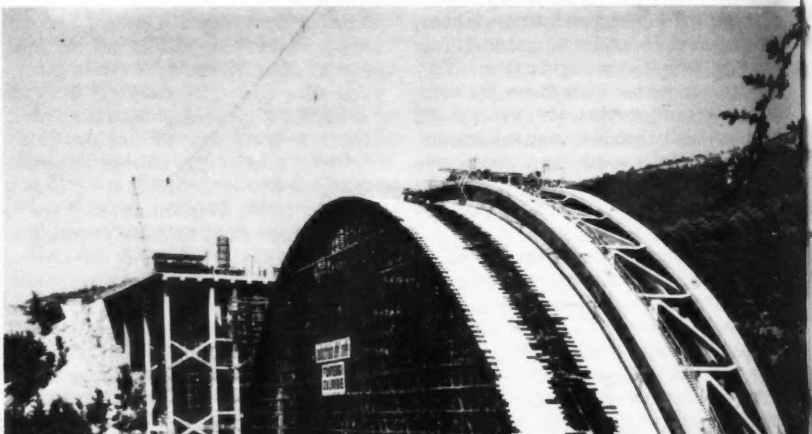
Road and Bridge Construction in Italy

A unique bridge construction is taking place near Bologna, Italy. It involves the displacement operation of a dismountable, tube-like centre arch of a twin-arch viaduct which crosses the Biscione torrent and was done with rollers. Many foreign and Italian bridge-builders were present during the operation in which the entire twin arch had to be moved over 15 yds. The arch has a maximum height of about 480 ft., a weight of 600 tons.

What is probably the most difficult part in the construction of the Autostrada Del Sole, Italy's "Motorway of the Sun", is now under way between Florence and Bologna. It entails crossing the rugged Apennine range of mountains. Costing £110 million, the motorway will run down the spine of Italy, connecting the industrial north with the south. Backed by government funds, it is a sound investment, for much of Italy's materials are transported by road. The surface of the new motorway will have eight lanes of traffic. It will be the most direct route possible, in true Roman road-building tradition. Each mile will cost approximately £130,000, much of the land having been brought from, at first, reluctant farmers. There has been a rush for sites to build filling stations and restaurants by the motorway.

The scheme entails the construction of 81 tunnels (a total distance of nine miles), 304 major bridges and 3800 minor ones, the longest bridge extending ¾ mile over the River Po in the north. The accent throughout the scheme has been on safety and beauty. There will not be one single crossroad, steep gradient, or dangerous curve in the entire 80-ft.-wide motorway. Work began in 1957 and is expected to be completed as scheduled, in 1963.

(*Below*) The centre arches of the bridge.



Land's Controversial Colour Theory

The meeting of the Colour Group of the Physical Society on November 11 consisted of a discussion of the experiments and theories of Dr Edwin H. Land (the inventor of Polaroid) about which it had been claimed that "A theory of colour that has stood for nearly three hundred years has suddenly been overthrown . . . the eye does not need 'red' wavelengths to see red . . . orange to see orange . . ." and so forth.

This claim was made by Francis Bello in an article in *Fortune* in May 1959. Land himself wrote an article for *The Scientific American* (May 1959) and gave a paper to the National Academy of Sciences. He illustrated his paper with remarkable demonstrations on a screen. The simplest account of his conclusions occurs in his statement: "Colour in the natural image depends on the random interplay of longer and shorter wavelengths over the whole visual field." His "natural image" means colour as normally seen in everyday life as contrasted with the abnormal colorimeter view of a tiny patch of coloured light surrounded by darkness. It is on the latter evidence that today's trichromatic theory of colour vision rests. So does the CIE international system of colour specification, using three variables.

At the Colour Group meeting Mr M. H. Wilson of the Goethean Foundation demonstrated several of the Land effects, such as the seeing of a reasonably wide range of hues on a screen picture that has resulted from the superposition of only two images, one from orange light, one from yellow light. He also demonstrated an effect first shown by Arthur Karp of the Engineering Laboratory at Cambridge a few months ago. It was that if two identical rasters of squares of regularly graded greys were illumined, one by red light, one by white light, then, contrary to Land's opinion, a wide range of hues was seen *if* and only if the squares were separated by white. This illusion, according to Karp, is due to a well known effect called "successive contrast" as the eye wanders naturally over a coloured scene.

Prof. W. D. Wright of Imperial College and others took part in the Colour Group discussion. A fair summary of this would be that these colour effects have been known to trichromatic theorists for a century and more, and what Dr Land has done is to demonstrate how much illusion and the processes of perception take part in the normal vision of a coloured scene. This is far from being a revolutionary overthrow of classical views and the trichromatic theory.

(*Left*) A section of one of the arches of the bridge.

Symposium on Fatigue of Welded Structures

The British Welding Research Association and the Engineering Department, Cambridge University, are jointly organising a symposium under this title. This is to be held in the Engineering Department, Cambridge University, from Tuesday, March 29, until Friday, April 1, 1960. A full discussion of the subject of fatigue of welded structures is thought to be of considerable importance at the present time. A good deal of research has now been done, but the expansion of welding fabrication in many areas where fatigue strength is a criterion is revealing new aspects of the problem. Present knowledge might therefore be usefully consolidated and new aspects considered by those people who are directly concerned with and interested in the investigation of the fatigue of welded structures.

Several papers will be presented by experts and will include contributions from the United States of America and from East Germany. These will deal primarily with structures fabricated by fusion welding processes. The fee for membership of the symposium is 15 gns. Further particulars may be obtained from the British Welding Research Association, Abington Hall, Abington, Cambridgeshire.

Rheology Meeting

The British Society of Rheology will hold a meeting in Manchester on April 7 and 8, 1960. Accommodation has been arranged at Ashburne Hall. Part of the meeting will be held in the Reynolds Hall in the College of Science and Technology. The meeting will include sessions on lubrication, disperse systems, and the methods and concepts of rheology; and a choice of visits to British Rayon Research Association, The Shirley Institute, Jodrell Bank, and the Fluid Motion Laboratory of the University of Manchester. Full details can be obtained from the Honorary Secretary, 8 The Broadway, Pontypool, Monmouthshire.

CERN Synchrotron Works for First Time

The European Organisation for Nuclear Research (CERN) announced that its big proton synchrotron for the first time on Tuesday, November 24, 1959, at 7.30 p.m., reached its designed energy—producing a beam of protons of an energy of 24,000 MeV. This is the culmination of six years' work of design and construction at the CERN laboratories at Geneva. The machine, 200 m. across and the most powerful in the world, has thus justified its designers and the faith of the twelve nations of Western Europe who came together six years ago to form CERN. Western Europe has at its disposal a unique tool of research for the exploration of the inner structure of the atom.

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